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Southern Electrical Business Conditions.

During the past few months we have heard complaining comments on business conditions which credit the situation to the change in chief executives at Washington, the policies of the new administration and the tariff. All these complaints are supported by the broadest possible general statements much after the order of statements by a pessimist out of a job, than which there is no greater mischief maker in the human family. If the tariff, currency legislation or new administration policies have been responsible for "tight money" or poor business conditions in any section of the North, East, West or South, the facts have been so well concealed that it would be a difficult matter to get enough of them together to support a good argument. If we were to offer a reason for the "poor business gossip," and we believe our suggestion is as good as any other—for who actually knows—we would say that much of the trouble is with the fellow who has held up his future plans and been responsible for his friends and neighbors holding up their future plans and these friends in turn responsible for their friends holding up future plans, all waiting for the crash to come by means of or on account of the tariff. Then, when the crash did not come and they realized the time they had lost fortifying themselves against their imaginations—well there is always an excuse for business failing to come up to a former standard and too many people are adepts at making excuses.

It is not our purpose to explain or interpret present political or financial conditions that may or may not exist, but it is our purpose in what follows to show that the prospects for business in the electrical fields of the South during 1914 are as good, if not better, than last year and equal to prospects of any January 1st heretofore. We have endeavored to secure expressions from electrical jobbers and others who are in touch with the Southern electrical situation and shall give exactly what they say in reference to it. To the question, "How do you find the electrical business in the South?" asked Mr. Washington Devereux, chief engineer of the Philadelphia Fire Underwriters, after a Southern trip, the following reply was received:

"The writer had a chat with Mr. Charles L. Eidlitz, of New York City, at the last Jovian convention and on the subject of, 'What's wrong with the electrical business throughout the United States?' in condensed form he said: 'Jobbers, manufacturers and contractors cut each other's throats and do not trust each other. (By cutting each other's throats I presume he meant cutting prices). The result has been that since the conception of the use of electricity for light and power purposes, which covers the period of about 32 years, he was not able to recall one single incident where a man had retired with profits to the amount of $100,000. In no other commercial industry would men, of capability be regarded as successful after having spent such a long period in the industry unless they were able to show that in that length of time they had accumulated at least $100,000 or more. In condensed form therefore, one may conclude that there has been a lack of co-operation in the electrical industry. Mr. Eidlitz did not touch upon the attitude of the central station toward the contractor and jobber in any detail, although he did state that he had sufficient data to prove that the central stations' attitude was not to co-operate.

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> "What's wrong with the electrical business? I believe the answer to this is found in the remark of a prominent gentleman made at one time at a convention. After having listened to numerous speeches, he was called on for a few remarks and said: 'I was just thinking how much happier we would all be and in what better condition our finances would be, if we only trusted each other a little more and we were altogether honest in our intent.' These remarks convey to me a whole lot in very few words. Whether they really apply to the electrical business or not I do not know, and if I did know perhaps under some conditions, I would not deem it wise to say so unless I had my $100,000 well invested and so thoroughly secured that no power on earth could break me. However, there is something surely wrong with the electrical business. We have **not progressed** commercially as rapidly as we should. No doubt the Society for Electrical Development will point the way to those conditions which we all desire to materialize."

Perhaps Mr. Devereux has admirably summed up the blackest side of the situation without being pessimistic, at any rate, his remarks are worth serious thought by manufacturers, contractors and electrical dealers and central stations, for it is plain that if the proper co-operation exists, the wrong can be taken out of the electrical business and at the same time the cry of hard-times automatically taken out of reports of business conditions. If the dose is co-operation, let's take it!

To look at the situation from another angle, let us investigate the statements of those parties who have confidence enough in their products, in the need of them and the fact that once they are sold they will be paid for, to such an extent as to defy all cries of poor business, and not only fill orders that come in voluntarily, but have gone out after those that did not come in, harder than ever. One concern doing an electrical jobbing business in machinery and supplies, having established an electrical department a little over a year ago at New Orleans, La., the Woodward, Wight & Company, reports as follows:

> "Within the last eleven months we have sold exactly thirty complete municipal and mill electrical power installations, ranging in cost from $2,500 in a few instances to $5,000 to $10,000 in most instances with other installations ranging as high as from $12,000 to $15,000. The majority of the larger outfits were steam turbine equipments to be used by large mills throughout the South. We have sold a majority of these plants on a finished, ready to run basis, or in other words, installed. We are at this time figuring on three complete installations of this nature and confident of securing the orders. Our general supply business has increased over 400 per cent over 1912 and we are carrying a heavy stock in order to handle our business promptly."

If an organization new to the electrical field can make a record like this one in eleven months, then those established organizations with equal facilities that can not report as good a record in proportion for the past year, should look within, for something is radically wrong.

As to conditions in another section of the South, we quote Mr. Julian Binford, Jr., president of the Binford Electric Company, Richmond, Va.:

> "In reply to your inquiry as to how we view the present business situation in the South, we take pleasure in advising that the remarkable way in which business has held up with us has been a great surprise. We hear all kinds of complaints from the North and West, from our competitors, as well as from banking circles, and unquestionably money is tight, nevertheless from our experience we find business remarkably good throughout the Southern states and from present prospects can not see that there will be any decline. In a conversation with one of our local bankers a few days ago, he brought up the question of poor business throughout the country and when he was 'pinned down' to it, admitted that throughout the South he could not complain and that as far as he could see general business conditions were of the best."

As to conditions in the South central states, we quote Mr. W. R. Herstein, secretary and treasurer, Electric Supply Company, wholesale jobbers at Memphis, Tenn. Mr. Herstein is by no means a pessimist, but rather a conservative in his methods and business relations. He says:

> "Business in our line as well as in the lines of other jobbers with whom we have talked, has been rather quiet in this section since the middle of July. Our observation has been that local conditions usually follow the lead of those in the East but the effects of conditions in the East do not become apparent here until after the lapse of a greater or less period of time. Consequently, the falling off in the business of this section after the middle of July was the usual consequence of tightness which began in the east in the early part of the year. The excellent cotton crop of the past fall, together with favorable cotton prices has however, tended to make things look better and to offset in a large degree the disastrous flood last April. Should this section of the country escape a flood next spring, the outlook for 1914 will be very encouraging."

As to conditions throughout the South as a whole, we quote Mr. A. F. Giles, district manager of the General Electric Company at Atlanta, through whose office reports of all Southern branch office sales pass. Mr. Giles says:

> "In reference to general business conditions in the South, I am glad to be able to state that for the year now ending, our company has enjoyed in this Southern territory and in fact in the country as a whole, a volume of business that is very gratifying, especially when we take into consideration that throughout the year there has been in certain quarters a feeling of uncertainty and pessimism in regard to business conditions. While there still exists some uncertainty as to the coming year, with the actual effect of the tariff readjustment not yet known, the financial outlook seems to be improving to some extent. If an improvement in the money market becomes well established, the public utility companies will naturally be able to finance extensions and improvements more readily than during the year and we may in that event, look forward to a large volume of business from the central stations and power companies.
>
> "While, of course, a large proportion of the business of an electrical manufacturing concern is dependent upon the purchasers of central station companies themselves, the field is being broadened more and more by the continued application of electric drive in industrial plants. This Southern territory is particularly fortunate in that it is covered by a net work of transmission lines radiating from water power plants and making available cheap and reliable power. This power situation cannot fail to have a beneficial effect upon the electrical industry. From these considerations, we can see no reason why that during the coming year, the electrical industry should not share fully in a general prosperity predicted for the South."

The information presented here seems sufficient to enable anyone fairly well informed on general conditions in the electrical field, to decide whether or not he has drawn a proper conclusion. In considering this matter we have only to suggest that the old adage, "Laugh and the world laughs with you, weep and you weep alone," has a broader interpretation than the mere sentiment expressed. Be a conservative if you will, be an optimist if you can, but be a pessimist, never!

Tall Buildings and Electrical Installations.

The statement by William C. Spiker in an article found elsewhere in this issue, that within the next five years, from twenty to thirty million dollars will probably be expended in the construction of tall buildings in southern cities and that during the past four years at least forty such buildings have been built at a cost of from twelve to fifteen million dollars, is worthy of some consideration. To any one who has visited the larger and even medium sized southern commercial centers, the so-called sky-scraper at once attracts attention with its imposing appearance against the skyline in contrast with the older types of one, two and three-story office and store structures yet in existence in goodly numbers. The presence of these tall buildings at once suggests progress and prosperity locally such as is now characteristic of all southern industries.

This tall building development is most conspicuous in the fast growing cities of the South having a population of 50,000 or more, such as Birmingham, Ala., Jacksonville, Fla., Atlanta, Ga., Nashville, Tenn., Mobile, Ala., Memphis, Tenn., Savannah, Ga., and New Orleans, La., which rank in rate of growth as given here. In these cities, the continual advance in price of centrally located real estate and store and office sites has been largely responsible for the invasion of the sky-scraper under conditions similar to those in northern and eastern commercial centers. Conditions have seemed to demand them. With the numerous examples in such centers of types of construction that have been found best suited to the conditions, it is to be supposed that the type of Southern sky-scraper will be equal to, in design and construction of its main features, if not in advance of those of the earlier types. At least this should be so and the building development of the newer southern centers should represent in years to come a decided progress in this direction. Whether or not the tendencies are in this direction at this time to an extent that might be expected, we shall leave the reader to judge from Mr. Spiker's remarks, which come from an engineer of considerable experience in design of structural steel and reinforced concrete construction in many cities of the South.

We concur with him, however, in his criticism of the tendency to install electrical work after haphazard plans and in too many cases after the building has been or is being constructed. The day has passed when a tall building can be designed without considerations for an elevator and provisions for a complete conduit system in advance of all construction work, and the quicker owners can be convinced of this, the more modern can such installations be made. In one of the cities above named, a certain building of seventeen stories is now practically complete, designed by capable engineers and without provisions for telephone and call bell wiring. If such must be installed it must be run along and nailed to the base boards or the walls opened and conduit inserted, the first scheme being most unsightly and the second most expensive. Such a breech of good engineering in the design of the building is entirely uncalled for and makes one wonder if what he would like to believe possible is a fair presentation of what may be expected in the future. In other words are the electrical engineers who should be interested in tall building design standing still or falling behind the procession of civil engineers and architects in this work, or do the architects and civil engineers assume in some cases too much responsibility in the design of these structures and fail to impress upon owners the need of calling in capable electrical engineers at the start of the work. The blame must lie somewhere—where shall it be placed?

The Power Trust and Public Distrust.

Slowly, it may be but surely nevertheless, public conviction is crystallizing about the idea of governmental regulation of the water power business. As yet such conviction is by no means universally held; but that the trend of sentiment lies in this direction, no one can doubt who has read the reports of the Fifth National Conservation Congress, held last November at Washington. Whether we shall have national regulation or state regulation is a question by itself and seemingly, an open question. That we must have some regulation, virtually all thinking men agree, and to the editorial writers, without exception, the congress mentioned stands as a mile post on the road thereto.

The water powers of the country are going to be monopolized. This is not an opinion but a fact and a fact perfectly known to all who are familiar with the hydro-electric industry. There are those of us who would like to see it a state monopoly, believing that thereby the interests of all the people might best be served. However this may be, we should all recognize that the thing to fear is not monopoly, but unregulated monopoly. Monopoly of the oil business resulted in the building up of the most marvelous business organization the world has ever known, yet we are all compelled to admit that this organization has resulted in some, if not much, general good. But even if we go further and admit as a possibility, what the Standard Oil Company claims to be the fact—even if it is true that oil is sold cheaper than it could have been sold without the existence of the oil monopoly—the world would be better off today if from the beginning, the monopoly had been held in check by a reasonable governmental regulation. The public does not object to profits, even if it does not benefit thereby, but it does object to inordinate profits.

Here is exactly where the shoe pinches. The public has learned that any monopoly, when allowed a free hand, will not be content with reasonable profits—it has a tendency to manipulate the market—to restrict output, and to do everything that shrewd brains can devise to crowd profits up to the top notch. The term monopoly or trust has, therefore, a tendency to suggest to the average mind oppressive conditions. Of all oppressive trusts, a power trust if ever one were formed, could be and probably would be oppressive in some degree. For this reason, as the old adage goes, "all good Indians are dead Indians," now likewise all "good trusts" are "regulated trusts." So the public is ready to say—or nearly ready to say: "Let the ten interests that control 65 per cent of all the developed water power in the United States go ahead and develop some more power, but don't let them become more powerful than the government itself in the process."

To consider the other side of the question—the regulation side—the fruits of a proper governmental regulation of the water power business can be observed by turning our eyes to the north and looking at Canada. Every reader of *Electrical Engineering* probably knows something of the Hydroelectric Power Commission of Ontario. This commission was created in 1906, and was given sweeping authority covering the whole field of power development within the Province. It might build power houses and transmission lines, make contracts to take power from existing companies, transmit and sell it to municipalities or individuals or if it saw fit, take over the power developments by condemnation. It could require any power company (whether using water power or steam), to open its books for inspection, and it could go into the power business anywhere, in competition with the existing companies. One of the first acts after thoroughly studying the situation was to contract to buy some 20,000 or 30,000 horsepower from the Ontario Power Company, of Niagara Falls, at the handsome price of from $9 to $10 per horsepower per year. Before doing this, its engineers estimated that a 100,000 horsepower plant could be built at Niagara, to produce a horsepower-per-year at the cost of $4.95.

To tell all that the commission has accomplished in these seven years would be much too long a story. In many cities the old companies have found, to their surprise, that they can sell power for less than half their former rates and still make money. In Toronto, it is said that the old company is doing 30 per cent more business at half the rate since the advent of the hydroelectric science. In Ottawa the cost of residential lighting has been reduced from 15 to about

5.4 cents per kilowatt-hour. In Winnipeg, prior to 1906, power and lighting were furnished by the Winnipeg Electric Railway Company, at prices ranging from 20 cents per Kw-hr. for house lighting to 12 cents per Kw-hr. for power. Under the guidance of the Hydroelectric Commission, the city itself built a hydroelectric plant with an initial development of 28,000 Hp. and an ultimate capacity of 100,000 Hp., and transmits the power a distance of 77 miles. At present, light for private lighting costs 3 cents per Kw-hr. with a 20 per cent discount for a five years' contract. Power in amounts of 100 Hp. and over is sold at ½-cent per Kw-hr. A special rate is made for cooking by electricity, this rate being 1.0 cent per Kw-hr., subject to a minimum monthly payment of 75 cents and a discount of 10 per cent for prompt payment. The private company charges the same rates as the city, although before the city built its own plant, the private company jeered at the estimates, claiming they were ridiculous. This company (the Winnipeg Electric Railway Company), was incorporated in 1892 with a capital of $300,000, and in 1911 the capital had been increased to $6,000,000, not including debentures (or bonds), and paid 12 per cent dividend. This stock sells today at 229¾. The company carried over into 1912 a surplus of $1,500,000 (see page 168, Second Annual Report, of the New York Conservation Commission).

How would "The Hydroelectric Power Commission of Georgia" sound? Or of Tennessee? Or Alabama? Let us see how matters stand with us in the South today. The citizens of a certain city located below the Mason & Dixon line were looking forward to the completion of a large hydroelectric development within a distance of 100 miles of its borders. The hydroelectric company had been given a franchise to sell light and power in the city. Prior to the completion of the transmission line, the local railway and light company had a monopoly of the city's business, generating electricity from steam. This company had been selling at rates which are thoroughly orthodox in our section—ranging from 10 cents per Kw-hr. for private lighting (with 20 per cent discount for prompt payment), down to about 1.5 cents per Kw-hr. for large factory installations with favorable power factor. Of course, the local company did not care particularly to see competition come in—not if it could help it, and it could help it. It agreed to take power from the hydroelectric company at the city's line and as a part of the agreement, the steam plant was to be kept floating on the line, with full boiler pressure maintained so that the load could be assumed by the local station at any time. The consideration was 5.5 mills. This suited the hydroelectric company, which then found it convenient to let its franchise to enter the city lapse. It also suited the local railway and light company, although the 5.5 mills is a little more than double the previous cost of coal for generating power by steam. Since interest and depreciation on the steam plant stand the same as before, and now some coal is burned non-productively—well, it is not as expensive as competition, and the citizens are paying the same old rates, and are wondering why it is that the "cheap" water power doesn't do them any good. J. A. Switzer.

[In publishing the comments of our readers on topics of interest, the editor of *Electrical Engineering* does not necessarily approve nor advocate the opinions expressed. We welcome discussions on all features and problems of the electrical industry, believing that a solution cannot be arrived at through discussions conducted "under cover." These columns are open for other opinions on this subject.—Editor].

Electric Sign Manufacturers to Organize.

In the December issue of *Electrical Engineering*, on page 537, mention was made of an organization of electric sign manufacturers, to be known as the National Association of Electric Sign Manufacturers. We are now advised that two separate agencies were at that time at work on the organization of the sign interests and our report that the manufacturers had recognized any one was in error.

The facts on the organization movement are as follows: On December 1st, representatives of some 20 sign and accessory manufacturing companies held a meeting at Hotel Sherman, Chicago, and discussed ways and means for a permanent association organization. At this time a committee was appointed to formulate definite plans of organization and this committee is now at work drafting a constitution and bylaws, to be discussed and considered for adoption at a meeting to be held in Chicago early in March of 1914. The committee consists of the following members: Mr. Norman B. Hickox, Greenwood Advertising Company, Knoxville, Tenn.; Mr. G. R. Hall, National Electric Sign Company, Jersey City, N. J.; Mr. H. I. Markham, Federal Sign System, (Electric), Chicago.

At the Chicago meeting, the discussion on features of organization brought out interesting points, which will have a bearing on the nature and purpose of the organization. A large number present favored co-operating with the National Electric Light Association and endeavoring to secure recognition on the program of the annual convention of this association, either as a part of the commercial section or as a separate section.

The purposes of the association in the main are: The betterment of competitive conditions, stimulation of cooperation with central station men, the securing of a universal adoption of the rules of the underwriters' laboratories, standardization of local city requirements for illuminated advertising, and the elimination of the present evil of stealing competitors' designs. As the matter now stands, the probable association organization will include as active members all sign manufacturers using the underwriters' label service, or having their products approved by the underwriters in the regular manner, and all accessory manufacturers as associate members. The result of the meeting in Chicago and the definite form of the organization will be announced later in these columns.

Officers of Alabama Light and Traction Association.

The Alabama Light & Traction Association at its annual meeting at Mobile, Ala., on November 21, 1913, elected the following officers for the present year. R. L. Ellis, Selma Lighting Company, president; T. K. Jackson, Mobile Electric Company, vice-president, and H. O. Hanson, Mobile Electric Company, secretary.

The association has for some time had under consideration the matter of affiliation with the Southeastern section of the N. E. L. A., as practically all of the larger companies of the Alabama association are also members of the Southeastern section. Inasmuch as the N. E. L. A. members in Alabama can get more from the affiliation with the Southeastern section, it seems advisable and quite probable that some definite action will be taken during the present year by which the smaller members will join the ranks and get the benefits that come from co-operation on a larger scale.

Hydroelectric Developments in Alabama

(Written Exclusively for Electrical Engineering.)

BY W. E. MITCHELL, ELECTRICAL ENGINEER, ALABAMA POWER COMPANY.

Details of Electrical Developments Completed and Under Way.

TWO years ago on the 5th of the present month, the Alabama Traction, Light & Power Company was organized with a capitalization of $50,000,000 for development of water powers and the operation of public utilities in the state of Alabama. This company controls and has merged with it, the Alabama Power Company, the Alabama Power Development Company, and the Alabama Interstate Power Company, and has purchased and now operates electrical properties in five Alabama cities, including New Decatur, Huntsville, Anniston, Talladega and Attalla. Its plans contemplate the development of hydro-electric plants and the construction of a network of high tension transmission lines of more than 800 miles, extending into every part of the state and connecting generating stations with a capacity, to be available within a few years, of more than 500,000 horsepower. This electrical energy will be used for industrial power, for traction and for lighting cities and towns. The present developments are being carried out by the Alabama Power Company. The company has purchased several power sites, but the work so far has been concentrated at two points—the Gadsden steam plant and Lock 12 hydro-electric plant on the Coosa river, which has an ultimate capacity of 80,000 Kva.

Already there is in operation a water power plant of 1,500 Kw. at Jackson Shoals and the steam plant at Gadsden, recently completed, of 12,500 Kva., in addition to the steam plants in the cities mentioned. The Lock 12 development, to be completed early during the present year, is situated about midway between Birmingham and Montgomery, it being 50 miles in each direction to these cities, which are the largest and most important in the state. The former is known as "The Pittsburg of the South," with vast iron and steel industries, and the latter the capitol of the state and an important center for the cotton trade.

In what follows the details of electrical construction for Lock 12 development and the Gadsden steam plant will be given, which together with the transmission lines, compose the development work thus far, of this important Southern organization. A later article will take up more fully the construction details of the Lock 12 plant, with illustrations of the equipment as installed.

LOCK 12 DEVELOPMENT.

The Lock 12 development involves the building of a gravity type dam of cyclopean concrete, nearly 1,400 feet long and 80 feet high, making available a head of 68 feet. The power house forms a part of the main dam and is 324 feet long by 80 feet wide and situated on the west bank of the river. A lock for navigation will be built on the east bank beyond the end of the main dam, by cutting a channel through a natural depression. Four 17,500 horsepower vertical, single runner turbines of the I. P. Morris design and manufacture will be installed at present, leaving space for two future units of the same capacity.

These turbines are the largest single runner units that have ever been installed in this country to operate under a head of 68 feet. The runners of these turbines are of cast iron, cast in one piece, 13 feet 3 inches in diameter. The speed is 100 revolutions per minute. This type of turbine represents a decided stride toward greater efficiency, greater simplicity, and a reduction of maintenance cost. Spiral casings and draft tubes for the units are molded directly in the concrete of the power house sub-structure. The thrust bearing is located above the generator, in which position it is possible to attain the greatest accessibility for this part of the unit. The weight of the generator shaft, rotating field and turbine runner is transmitted to a generator supporting ring, the lower surface of which rests upon the cast iron speed ring, surrounding the runner. This weight is transmitted in turn through the vanes of the speed ring to the concrete foundation below.

A passage leads down from the generator floor to the operating deck just above the head cover of the turbine and on this operating deck is located the entire operating mechanism of the turbine, consisting of two horizontal operating cylinders or servo-motors connected through reach rods, an operating ring, links and levers to the upper ends of the guide vane shanks, which project through the stuffing boxes in the head cover.

With only one runner and therefore one set of operating mechanism, the operation of this turbine is extremely sim-

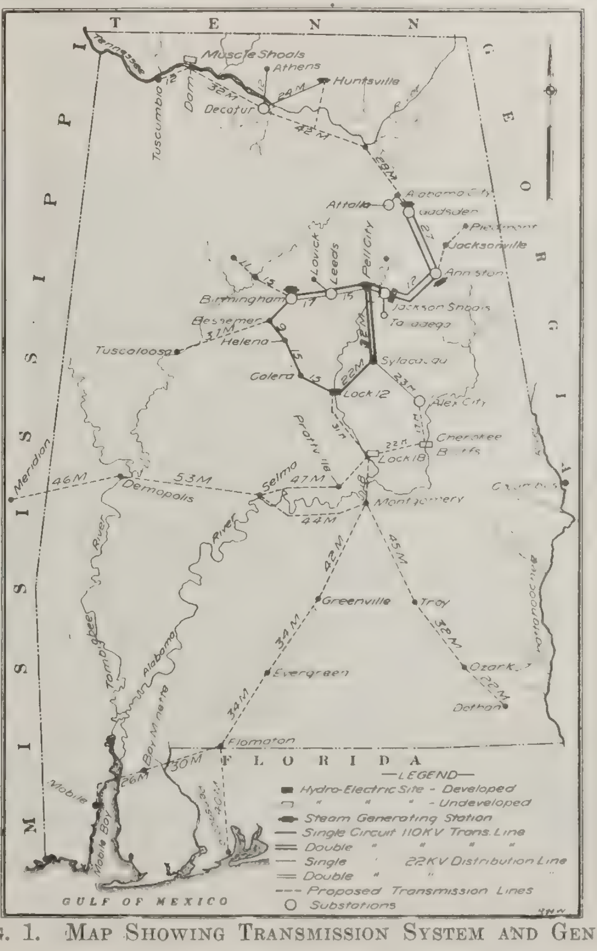


FIG. 1. MAP SHOWING TRANSMISSION SYSTEM AND GENERATING STATIONS ALABAMA TRACTION, LIGHT & POWER CO

ple. The only part not accessible during operation is the runner and the lower part of the guide vanes. The manufacturers claim a higher efficiency for this type of turbine than has ever been attained from any turbine regardless of type, speed or head, and it is expected therefore that interesting efficiencies will be obtained from tests on the wheels when installed.

On low head developments it is considered advisable to obtain as high a speed as possible. In former years therefore, in order to attain a reasonably high speed it was considered necessary to resort to two runner units. Of late, the development of high speed turbine runners for low heads, however, has made it possible to attain high speeds with only one runner per unit. With these high speeds there is necessarily a very high discharge velocity, and in order to regain the energy contained in this discharge from the turbine runners, a draft tube construction has been demanded that would diffuse the water very gradually, presenting no sharp bends. With the two runner units, it has usually been impracticable to avoid abrupt changes in the shape and sectional area of the draft tube and therefore it follows that with such units equipped with high speed runners, a very high efficiency is not possible. For conditions similar to those under which the Alabama wheels at Lock 12 will operate, the multi-runner turbines are rapidly becoming obsolete.

The single piece shaft of the turbine runners connects directly to the generators, which are Westinghouse, 3-phase, 60-cycle, 13,500 Kva. (10,800 Kw. at 80 per cent power factor) 6,600-volt, 100 rpm. machines. These units are unique for their simplicity and compactness and are entirely self-contained. A cast iron speed ring is first bolted in place above the draft tube, and to this is bolted a cast iron foundation ring which extends up to the generator floor level. The generator is placed directly on this ring so that as mentioned in describing the turbine, the load is transmitted directly to the solid foundations through the foundations and speed rings. This makes the erection of the units very simple, for when the speed ring is properly set, all the rest of the apparatus is compelled to line up properly. The bearings are of the Kingbury type, which have been operating so successfully in recent installations. Direct connected exciters are used and are carried on an extension of the shaft directly above the Kingsbury bearings. The exciters are 150 Kw. at 250 volts. The turbine governors are of the Lombard Governor Company make, and of the same type as supplied the Mississippi River Power Company for the plant at Keokuk.

The generators are connected in "Y" and the neutral brought out. Eight Thermocouple exploring coils are installed in each generator. Each generator has its individual TA regulator. One motor generator exciter of 150 Kw. capacity will be installed for emergency service, arranged so that it can be connected to any generator. Nothing but the exciter shunt field leads are brought to the switchboard, the exciter armatures being connected through a double-pole-double-throw switch to the generator fields. All switches and switchboards are furnished by the General Electric Company.

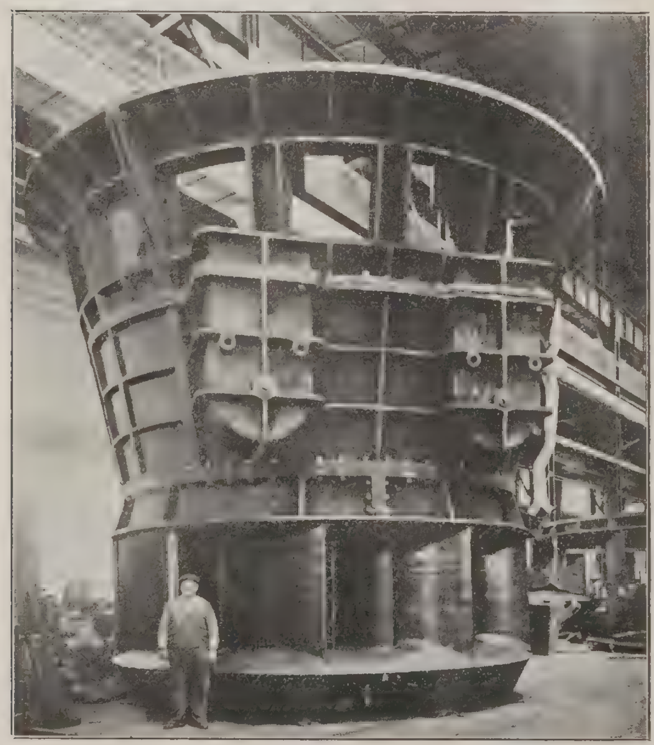


FIG. 2. VIEW OF SINGLE RUNNER HYDRAULIC TURBINE UNIT FOR LOCK 12 STATION—THE LARGEST INSTALLED IN THIS COUNTRY.

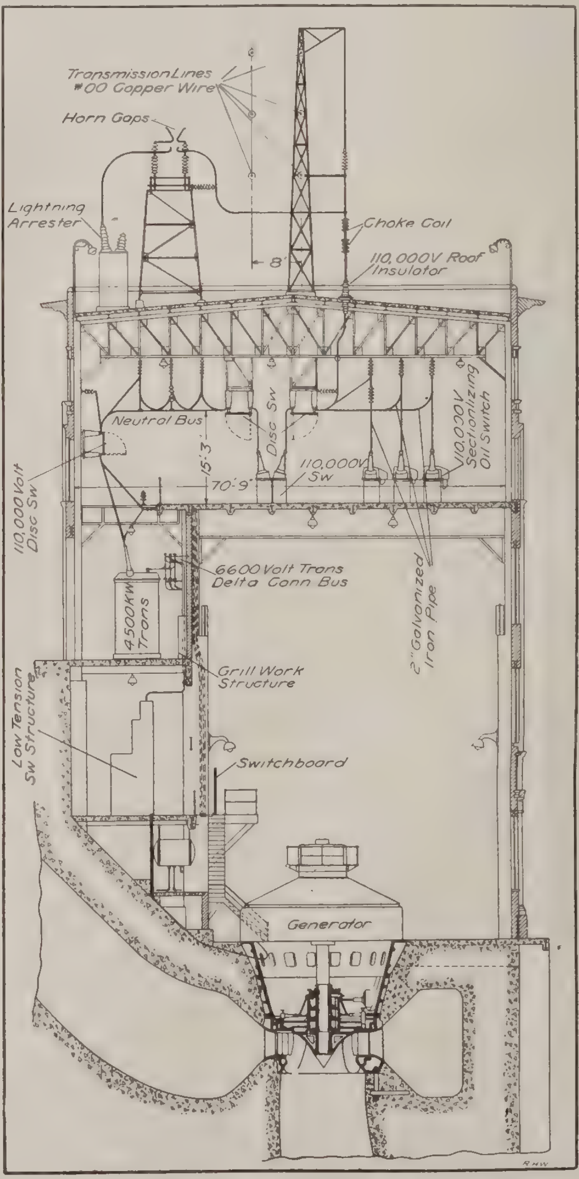


FIG. 3 SECTION OF LOCK 12 HYDRO-ELECTRIC STATION THROUGH SWITCHING GEAR.

The switching and control of the Lock 12 station are extremely simple and flexible. Each unit may be connected by an oil switch, either directly to its own bank of transformers or to a 6,600-volt transfer bus. The high tension switches are of the in-door type and will be located on the upper floor of the power house above the main generators.

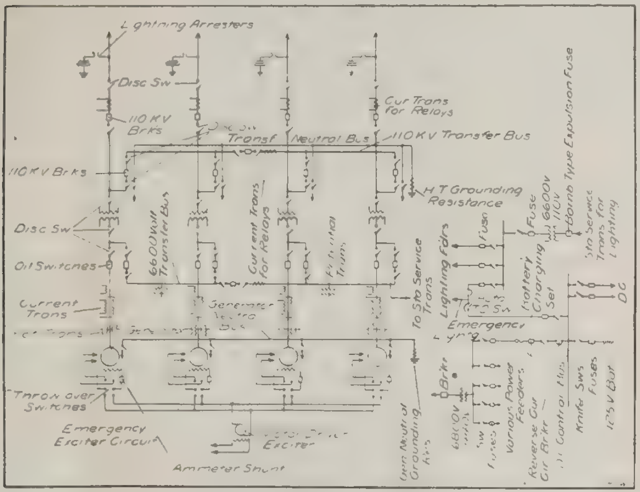


FIG. 4. LAYOUT OF BUSSES AND SWITCHING EQUIPMENT FOR LOCK 12 DEVELOPMENT.

Each bank of transformers consists of three single-phase, oil insulated, water cooled, 60-cycle, 4,500 Kva., 6,600 to 110,000-volt transformers, delta connected on the low and star on the high tension side. Four banks of transformers will be installed at present, one for each generator. On the low tension side, these transformers may be connected either directly to a generator or to a transfer bus and on the high tension side, to either an outgoing 110,000-volt line or to a 110,000-volt transfer bus This permits putting any machine on any transformer bank and line. A complete water cooling system will be installed for the transformers, and also an oil-storage and an oil-filtering drying outfit. Aluminum cell electrolytic lightning arresters will be arranged on the roof.

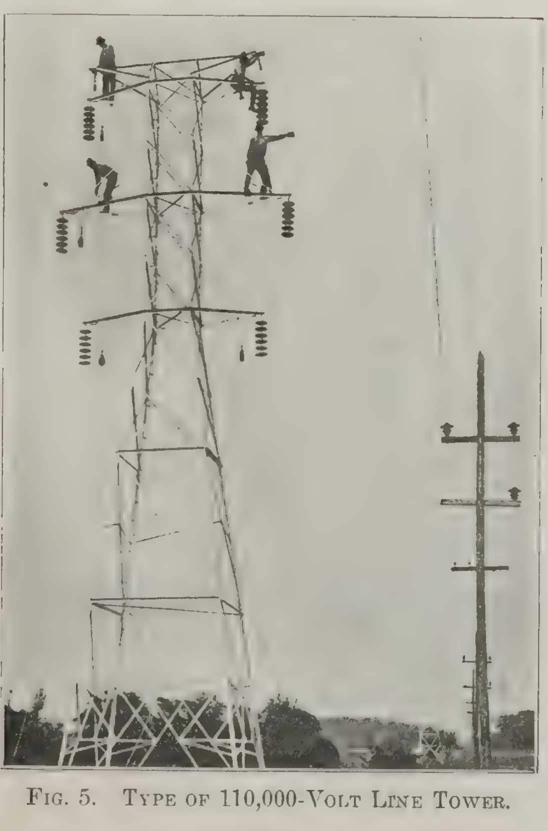
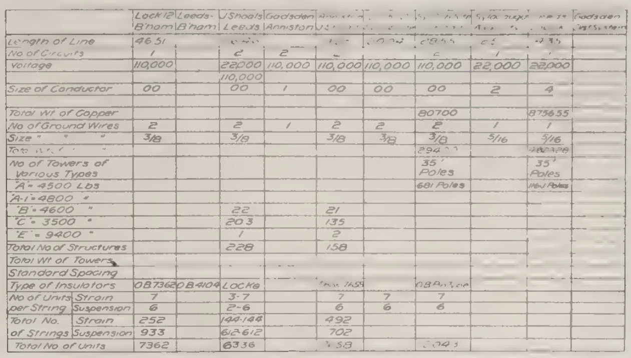


FIG. 5. TYPE OF 110,000-VOLT LINE TOWER.

TRANSMISSION LINES AND TOWERS.

A transmission voltage of 110,000 volts was chosen after a careful investigation of the present and future market, and two double circuit transmission lines are under construction, using towers manufactured by the American Bridge Company. One line goes directly from Lock 12 to the Birmingham sub-station, a distance of 50 miles, and the other crosses the river and goes to Gadsden, via Sylacauga, Talladega, Jackson Shoals (where the 1,500 Kw. water power plant is located), and Anniston to Gadsden, tying in there with the Gadsden steam plant.



	Lock 12 B'ham	Leeds-B'ham	J Shoals Leeds	Gadsden Anniston	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Gadsden [illegible]
Length of Line	46.51		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
No of Circuits	1		2	2	[illegible]		[illegible]	1	[illegible]	
Voltage	110,000		22000 110,000	110,000	110,000	110,000	110,000	22,000	22,000	
Size of Conductor	00		00	1	00	00	00	2	4	
Total Wt of Copper							80700		875655	
No of Ground Wires	2		2	1	2	2	2	1	1	
Size " " "	3/8		3/8		3/8	3/8	3/8	5/16	5/16	
Total [illegible] "							294[illegible]		[illegible]	
No of Towers of Various Types							35' Poles		35' Poles	
'A' = 4500 Lbs							681 Poles		[illegible] Poles	
'A-1' = 4800 "										
'B' = 4600 "			22		21					
'C' = 3500 "			203		135					
'E' = 9400 "			1		2					
Total No of Structures			228		158					
Total Wt of Towers										
Standard Spacing										
Type of Insulators	OB7362	OB4104	Locke		[illegible] 7659		OB [illegible]			
No of Units per String Strain	7		3-7		7	7	7			
No of Units per String Suspension	6		2-6		6	6	6			
Total No. of Strings Strain	252		144-144		492					
Total No. of Strings Suspension	933		612-612		702					
Total No of Units	7362		6336		[illegible]58		[illegible]			

FIG. 6. DATA COVERING TRANSMISSION LINE EQUIPMENT.

Each circuit will consist of No. 00 copper, seven-strand conductor, drawn to 55,000 pounds tensile strength. Six disc Thomas, Locke or Ohio Brass insulators are used on suspension and seven discs on the strain insulators. These six disc units were tested to 350,000 volts dry, and 255,000 volts wet before they flash over and are designed to always flash over before puncturing. The mechanical strength test is a tension of 5,000 pounds, applied in line with the axis of the insulator, and samples tested to destruction must not fail under less than 10,000 pounds pull.

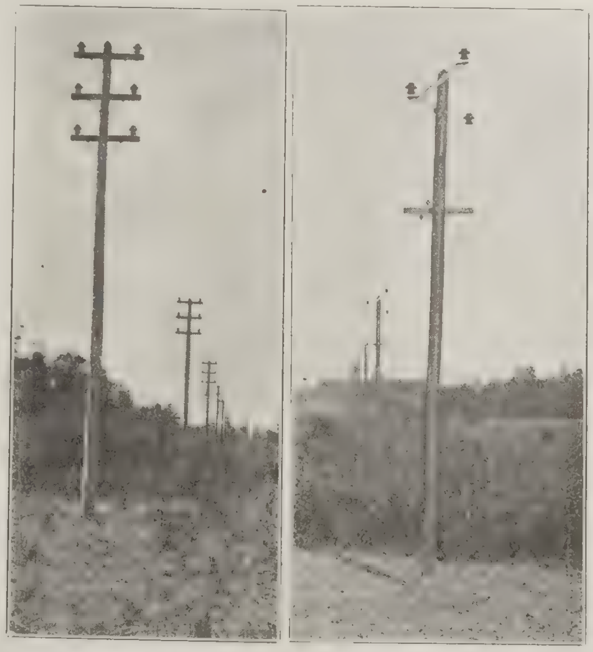


FIG. 7. SHOWING 22,000-VOLT WOOD POLE LINE CONSTRUCTION.

The transmission line from Anniston to Gadsden, 27 miles, is of double circuit, constructed on Miliken Brothers towers, the conductors having a horizontal spacing of 15 feet and a vertical spacing of 9 feet. These towers are

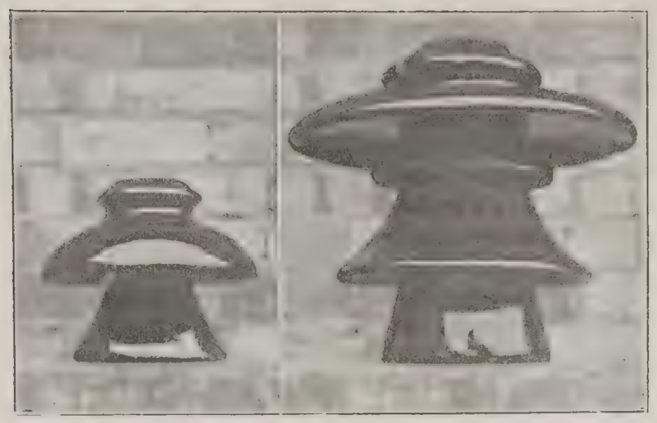


FIG. 8. INSULATORS USED ON WORK POLE TRANSMISSION LINES.

spaced on an average of 7.8 to the mile, with 1,990 feet the longest and 672 feet the average span. The clearance to ground is 25 feet. This line carries a single ground wire while all other lines carry two ground wires. With the exception of this line, the details of all transmission lines are standard, using three types of towers, known as A, B and C, with two ground wires, No. 00 conductors, six disc insulators on suspension, and seven disc insulators on strain, with a minimum clearance of conductors above ground of 25 feet, and conductors spaced 10 feet in a vertical plane and 15 feet horizontally on top and lowest cross arms and 19½ feet on middle cross arms.

Over rough country, such as traversed by the line from Lock 12 to Birmingham, the "Type A" tower is used, which weighs 4,500 pounds and is 68 feet high. It carries two ground wires and has 10 feet vertical spacing between conductors, with a horizontal spacing as mentioned above, which is designed to avoid any possibility of trouble due to the lines coming together when they unload sleet or ice unequally. These towers are erected with an all-metal footing 2.5 feet square, set 7 feet in the ground with no concrete. The base is 15 feet square and the tower designed for normal spans of 700 feet with 1,200 feet maximum.

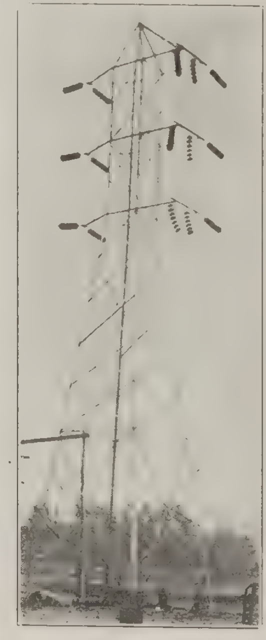
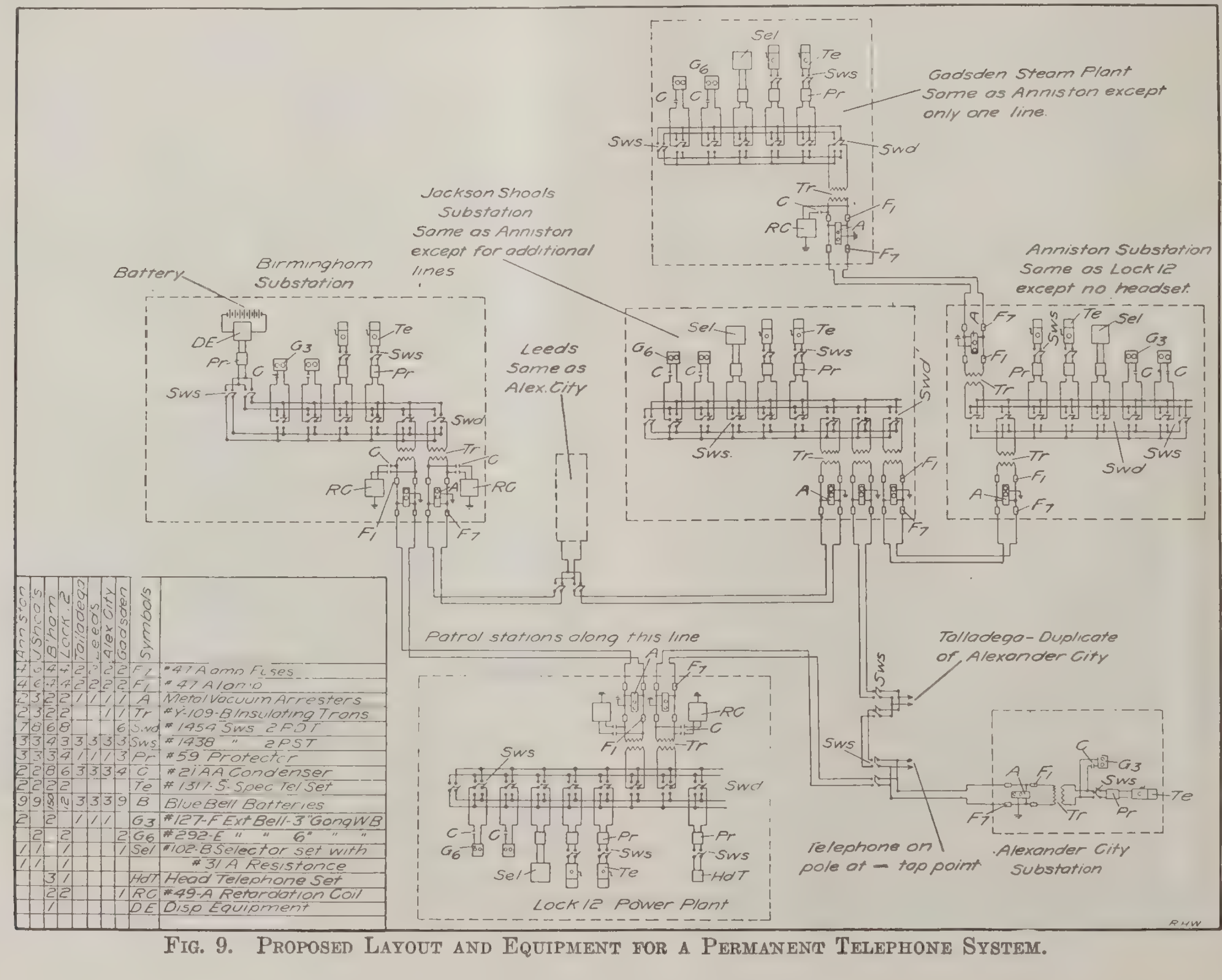


FIG. 10. TYPE OF 110,000-VOLT STRAIN TOWER.


Gadsden Steam Plant Same as Anniston except only one line.
Sel
G6
C
Te
Sws
Pr
Swd
Tr
F1
RC
A
F7
Jackson Shoals Substation Same as Anniston except for additional lines
Birmingham Substation
Battery
DE
G3
Leeds Same as Alex. City
Anniston Substation Same as Lock 12 except no headset.
Patrol stations along this line
Talladega- Duplicate of Alexander City
Telephone on pole at — tap point
Alexander City Substation
Lock 12 Power Plant
HdT
R.H.W.

Anniston	J Shoals	B'ham	Lock 2	Talladega	Leeds	Alex City	Gadsden	Symbols	
4	6	4	4	2	2	2	2	F_7	#47 A amp Fuses
4	6	4	4	2	2	2	2	F_1	#47 A 1 amp
2	3	2	2	1	1	1	1	A	Metal Vacuum Arresters
2	3	2	2			1	1	Tr	#Y-109-B Insulating Trans
7	8	6	8				6	Swd	#1454 Sws 2PDT
3	3	4	3	3	3	3	3	Sws	#1438 " 2PST
3	3	3	4	1	1	1	3	Pr	#59 Protector
2	2	8	6	3	3	3	4	C	#21 AA Condenser
2	2	2	2					Te	#1317-S-Spec Tel Set
9	9	15	12	3	3	3	9	B	Blue Bell Batteries
2		2		1	1	1		G_3	#127-F Ext Bell-3" Gong WB
	2		2				2	G_6	#292-E " " 6" " "
1	1		1				1	Sel	#102-B Selector set with
1	1		1						#31 A Resistance
		3	1					HdT	Head Telephone Set
		2	2				1	RC	#49-A Retardation Coil
		1						DE	Disp Equipment

FIG. 9. PROPOSED LAYOUT AND EQUIPMENT FOR A PERMANENT TELEPHONE SYSTEM.

The foundation mentioned is standard for all line towers and consists of a steel grillage made up of steel angles. No concrete is used for tower foundations except at river crossings and on these heavy concrete foundations are used. In wet or soggy places, field stones are used above and below tower footings.

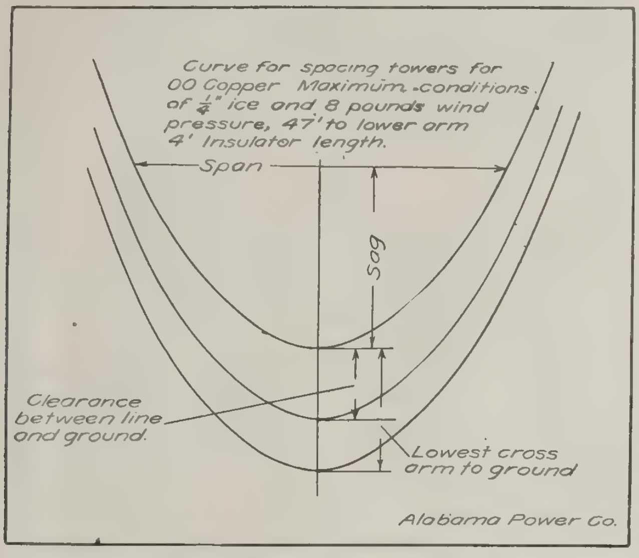

Curve for spacing towers for
00 Copper Maximum conditions
of $\frac{1}{4}$" ice and 8 pounds wind
pressure, 47' to lower arm
4' Insulator length.
Span
Sag
Clearance
between line
and ground.
Lowest cross
arm to ground
Alabama Power Co.

FIG. 11. CURVE USED WITH CONTOUR MAP FOR LOCATION OF TRANSMISSION LINE TOWERS.

On flat sections of the country traversed by transmission lines such as between Anniston and Sylacauga, a light tower known as "Type C" is used with a heavy tower weighing about 4,700 pounds used every mile. "Type C" tower weighs 3,600 pounds and is 65 feet high and has the same spacing of the arms as "Type A" tower. It also carries two ground wires and designed for a normal spacing of 600 feet and a maximum span of 900 feet, the base is 16 feet square. The line between Jackson Shoals and Leeds uses these light towers. The line from Leeds to Birmingham will be of the same construction as the line between Lock 12 and Birmingham and be started early in 1914.

The strain towers are known as "Type B" and weigh 4,700 pounds. The base is 17 feet square and otherwise is of the same general construction as "Type C" tower. The "Type B" towers are used at all angles over three degrees and up to 35 degrees. When on a tangent, "Type B" towers will be used every 2½ miles and the lines strained up at these points. The right of way for transmission lines is 100 feet in width.

At dead ends for sub-stations an extra heavy tower is used weighing 9,000 pounds, of the same design as other strain towers. At the point where the 22,000-volt line from the steam plant to Gadsden crosses the Coosa River, a special double *A* type of tower is used, 80 feet high on a span of 600 feet. No. 1 copper is used with a clearance of 65 feet above high water. Where the Coosa River is crossed at Seddon, Ala., on the line from Jackson Shoals to Birmingham an enlarged design of regular line tower is used, 130 feet high for a span of 1,050 feet. These two towers weigh 30,000 pounds each.

TELEPHONE SYSTEM.

Since uninterrupted service was considered the first criterion, a careful study was given to the telephone system, and it was finally decided to install telephone lines on separate creosoted pole lines 10 feet from the edge of the right of way. Twenty-two-foot poles are used with a single cross arm. No. 8 hard drawn wire is used throughout and poles are spaced 175 feet, with the lines transposed every five poles. Porcelain insulators designed for 6,600 volts are used.

Electrolytic lightning arresters are installed on all 110,000-volt lines as they leave the generating stations and just before lines go into transformers at Anniston, Jackson Shoals and all other sub-stations except Birmingham, where they are placed in the lines. Lightning arresters are also installed on 22,000-volt feeder circuits at the sub-stations. At 22,000 volts and lower voltage sub-stations, however, the horn-gap type of arrester is sometimes used instead of the electrolytic type.

DISTRIBUTION LINES.

All distribution lines will be 22,000 volts and for single circuit lines, creosoted, long leaf yellow pine poles, with 12-pound treatment, will be used with wishbone type metal cross arms and pin type insulators. Double circuit lines will be built on either poles or flexible towers of the Archbold-Brady type. Both pole and tower lines will carry a ground wire. The voltage of 22,000 was chosen on account of a large amount of the prospective load being widely scattered. On these 22,000-volt lines near cement and brick

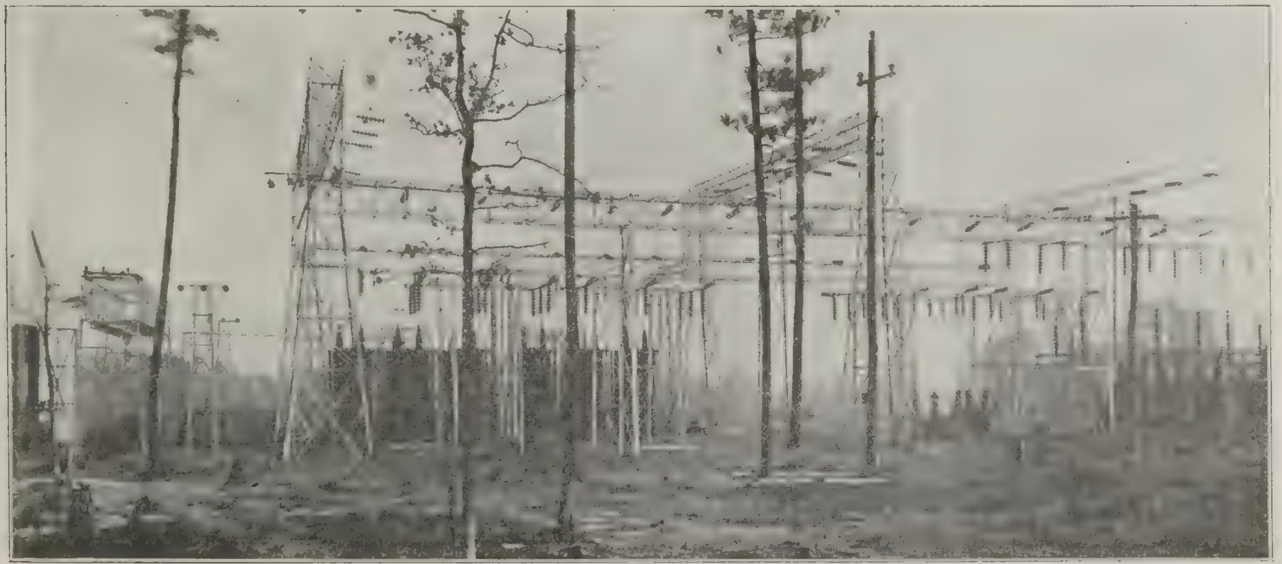


FIG. 12. SUB-STATION AT GADSDEN STEAM PLANT, SHOWING ARRANGEMENT FOR 110,000-VOLT LINES AT RIGHT, AND 22,000-VOLT LINES AT LEFT.

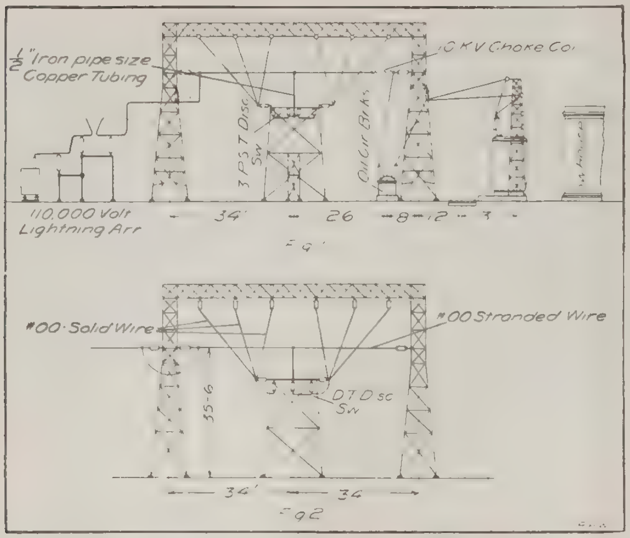


FIG. 13. SECTIONS OF ANNISTON SUB-STATION SHOWING ARRANGEMENT OF EQUIPMENT.

plants, it has been found necessary on account of deposits of dust on the insulator which reduces surface resistance when wet, to use insulators designed for 60,000 volts. The 110,000-volt sub-stations are now installed at Gadsden, Anniston and Jackson Shoals, and planned for Magella, near Birmingham. The 22,000-volt sub-stations are now installed at Talladega, Leeds, Lovick, Alexander City, Gadsden and Attalla.

THE GADSDEN AND OTHER OUT-DOOR SUB-STATIONS.

The out-door sub-station at the Gadsden stream plant is out of the ordinary, in that it is designed to take care of four 110,000-volt transmission lines stepping up a generating voltage of 2,300 at the steam plant to either 22,000 or 110,000 volts, and steps down from the 110,000-volt transmission lines coming in, to 22,000 volts. Two banks of transformers designed with three windings are installed, which step up as mentioned to either 22,000 volts for the local distribution system or to 110,000 volts for high tension transmission. Transformers are single-phase, 2,100 Kva. each, with each winding designed for full capacity. These are the first of this type installed in the South. All transformers and oil switches are of the out-door type. As shown in Fig. 12, the 110,000-volt lines are provided for at the right of the sub-station structure and the 22,000-volt lines at the left.

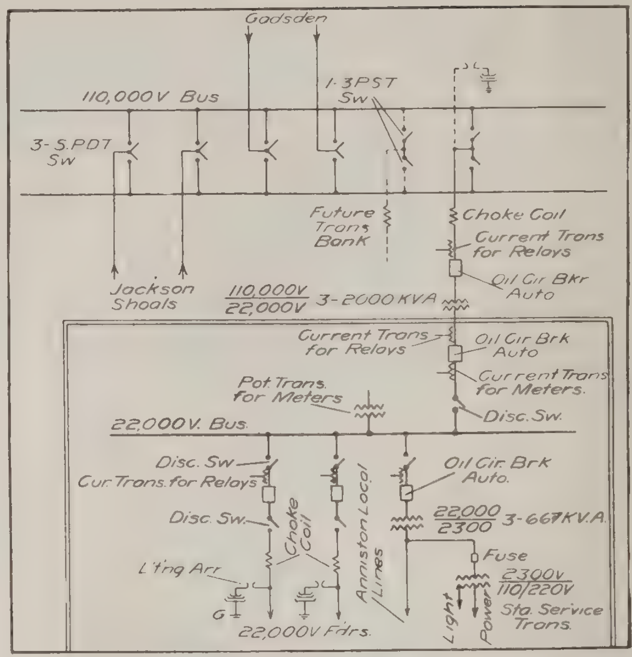


FIG. 15. DIAGRAM OF CIRCUITS FOR ANNISTON SUB-STATION.

All of the 110,000-volt sub-stations to be installed throughout the system are to be of the out-door type and after the design of the one now installed at Anniston shown

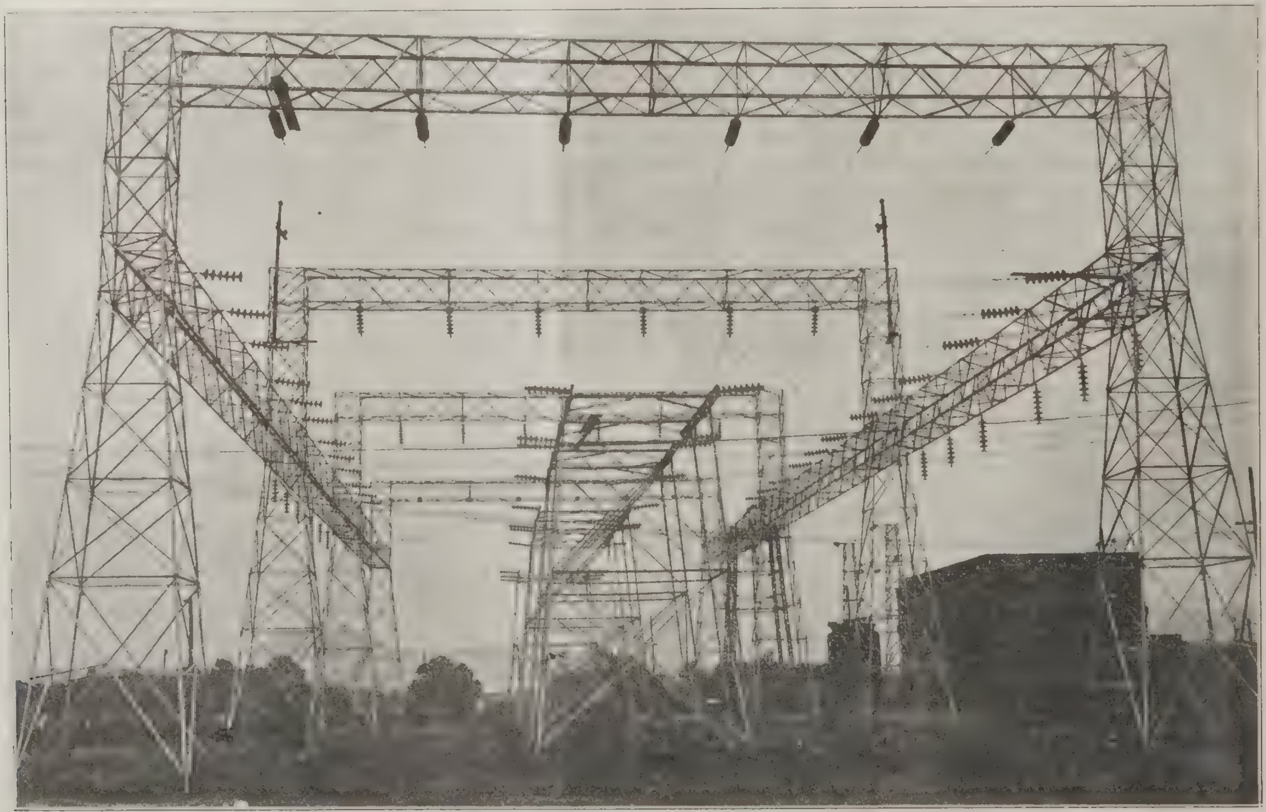


FIG. 14. SUB-STATION AT ANNISTON, ALABAMA 110,000-VOLT STATION FOR SYSTEM.

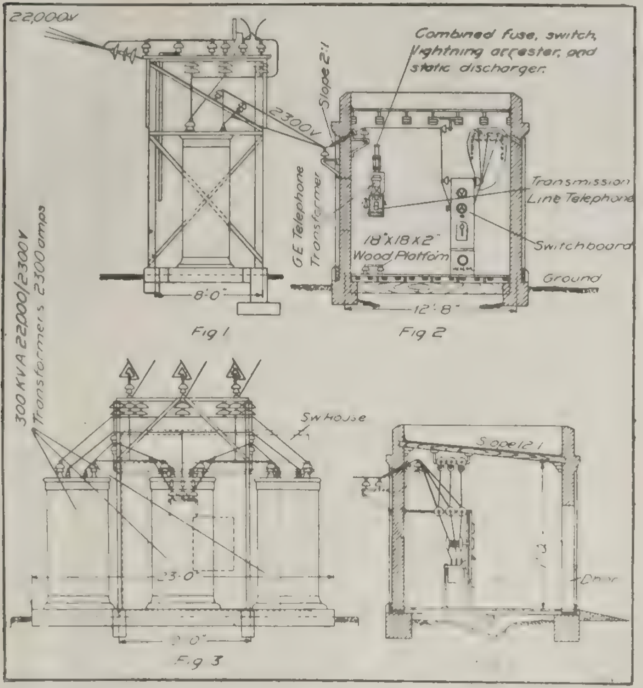


FIG. 16. SECTIONS OF ALEXANDER CITY SUB-STATION, A TYPICAL 22,000-VOLT STATION.

in Fig. 14. They will be standardized as to size and type on 3,000, 6,000 or 10,000 Kva. capacity. A small building will be constructed in connection with each to house the meters and control apparatus. A spare transformer is carried at all stations of 10,000 Kva. or larger. The smaller stations will have transformers connected in delta, so that in case of trouble to one transformer the other two can be operated in open delta. All transformers will be single-phase. The transmission lines will be sectionalized at every transformer station or about every 25 miles so that line trouble can be quickly located and repaired.

GADSDEN STEAM STATION.

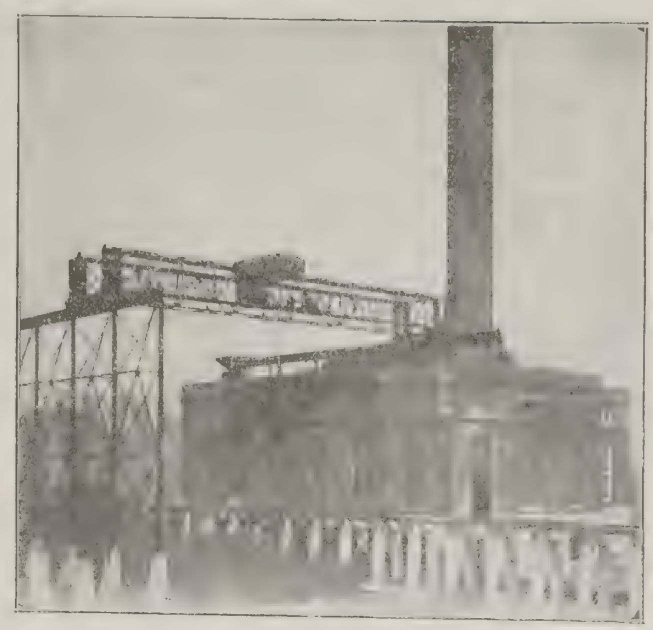


FIG. 18. VIEW OF GADSDEN STEAM STATION.

The Gadsden steam plant is located on the bank of the Coosa River, about two miles from the city of Gadsden. Construction on this plant was begun by the Alabama Power Development Company after plans by Sargent & Lundy, of Chicago, in November, 1912, and power delivered in July, 1913. This is a time record for construction that has never been equalled in the South, and but few times elsewhere, for a plant of its size and for the number of working days between the dates mentioned, interrupted many times by floods and high water. This station has a generating capacity of 12,500 Kva. and will serve to build up the load for the present water power system until it is in operation, when it will be used as a reserve plant. Judging from the river gaugings taken over a period of 14 years, the steam plant will increase the permissible sale of primary 50 per cent load factor power, from the water power system by 20,000 Kw.

The station has a concrete sub-structure and a brick and steel super-structure as shown in Figs. 18 and 19. The main or operating floor is elevated about 10 feet above the ground and divided practically in the center by a curtain wall which separates the turbine room in which is installed two 6,250 Kva. horizontal Curtis turbo generators from the pump and boiler rooms. The boiler feed pumps and dry vacuum pumps for condensers are located between the turbines and the boilers together with a steam turbine driven exciter of 100 Kw. capacity, another exciter of the same capacity being motor driven and located near the station switchboard. The turbine room is well arranged for convenient operation with a switchboard of 12 panels completely equipped with the necessary indicating and recording instruments. Special lighting provisions are made both during day and night, by means of ample window space and a sky light. Ten condulet outlets are arranged over the operating floor containing 250-watt tung-

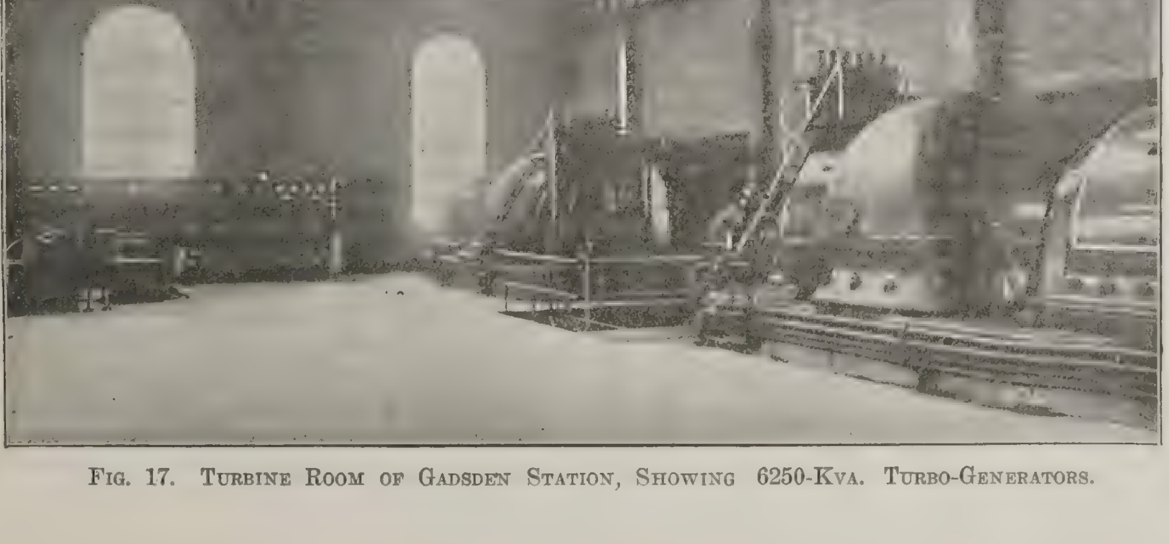


FIG. 17. TURBINE ROOM OF GADSDEN STATION, SHOWING 6250-KVA. TURBO-GENERATORS.

sten lamps for artificial illumination. A 35-ton Niles Crane provides for repair work on the turbine floor.

The generators are of the three-phase, 2,300-volt, 60-cycle, General Electric type operating at 1,800 rpm. The 2,300-volt leads from them are carried in ducts through the concrete floor and run on supports on the ceiling of the basement to the control room and switchboard. The outgoing 2,300-volt lines leave the station for the out-door sub-station through a tunnel in three pairs of three-phase cable, terminating in a roomy manhole at outdoor sub-station located above the power house some 400 feet. Delta connections are made up in this manhole and leads taken to the transformers where the voltage is raised to 22,000 and 110,000 and transmitted over double circuit, wood pole and steel tower transmission lines. The capacity of the cables between steam plant and sub-stations are such that any one pair of cables may be out of commission and the remaining two carry the load. All control switches and switchboards are located in the main power house.

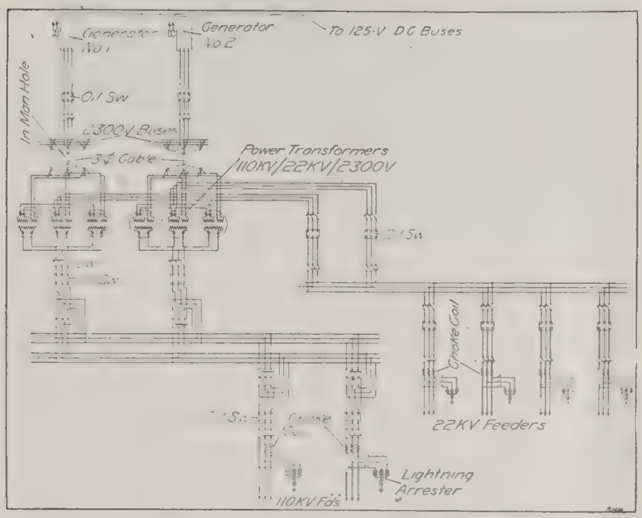


Fig. 19. Wiring Diagram for Gadsden Steam Station and Sub-Station.

STEAM PLANT EQUIPMENT.

The boiler equipment consists of six 600 horsepower Babcock and Wilcox boilers with Murphy stokers and carries a working pressure of 185 pounds. Coal is dumped from cars run on a tressle as shown in Fig. 18, into a coal storage yard of 2,800 tons capacity, where it is handled by a traveling crane with a two cubic yard grab bucket and dumped into a crusher and hopper above the boilers to supply the stokers.

The entire steam plant is laid out on a unit system. Boilers are set in three pairs with arrangements so that any pair can supply steam to either turbine. The steam pumps and other steam driven auxiliaries are arranged in duplicate with provisions so that the same unit can serve either turbine, pair of boilers or condensers. Boiler feed pumps are of the Worthington reciprocating type and the dry vacuum pumps are of the Laidlow Dunn Gordon type.

CONDENSING EQUIPMENT.

Steam from the turbines is admitted to a vertical Worthington surface condenser located in a pit directly under the turbines. Circulating water is pumped from the river near the station by centrifugal pumps driven by Terry steam turbines, the water returning by gravity to the river. A condenser is installed for each turbine each equipped with separate circulating pumps. Condensation from the condensers is pumped from the hot wells by Terry steam turbine driven centrifugal pumps, to a Webster Star vacuum heater. At certain times during operation, there is more hot water than can be handled through the heater, and to prevent wasting this water and be able to return it to the boilers at times when there is a maximum demand for feed water, a hot water storage tank is provided. This tank is piped to the feed water heater, so that when the heater reaches its maximum capacity, a float valve opens a line to it and the excess hot water flows into the tank for storage. When the demand on the heater is greater and the water falls below a predetermined level, another float valve is operated and a return line from the storage tank permits the hot water to flow from it to the condensers and be pumped back to the feed water heater by means of the hot well pumps. To insure a certain level of water in the storage tank, a float valve connection is made to the house service cold water line which operates automatically. The auxiliaries are connected to a common exhaust line which leads to the feed water heater and provided with an atmospherical relief. As the plant is now operated a boiler feed of 215 degrees F. is secured. The water taken from the river for the condensers and heaters passes through a Jewell water filter.

Fig. 20. Switchboard at Gadsden Steam Station.

STATION LIGHTING AND POWER.

The arrangements for station lighting and power are provided through three 20 Kw. single-phase transformers for the power demand and one 10 Kw. single-phase transformer for lighting. A storage battery of 61 cells providing 120 volts is installed to supply lighting service in case the station power fails and is arranged so as to be automatically cut in circuit when the station power goes off.

The engineering work in connection with the developments completed and underway by the company is done by a corps of engineers with offices at Birmingham, Ala. The engineering staff is headed by E. A. Yates, as chief engineer with Mr. E. L. Sayers as assistant chief engineer, Mr. W. E. Mitchell as electrical engineer and Mr. O. G. Thurlow, as designing engineer. Mr. James Mitchell, of London and New York, is president of the Alabama Traction, Light & Power Company, with Mr. Frank S. Washburn, president, and Mr. J. W. Worthington vice-president of the Alabama Power Company, and Mr. F. H. Chamberlain, general manager.

Progress of Southern Water Power Developments During 1913

(Contributed Exclusively to Electrical Engineering).

BY J. A. SWITZER.

THE year 1913 will be notable in the history of Southern water power development, because it marks the completion of a number of large power plants, rather than the inauguration of much important new work. The status of the hydroelectric industry has undergone no radical change, and the drama proceeds apace, with the public constituting an intensely interested audience. Quite evidently the public has not yet made up its mind as to the role it shall play, and for the present is content to watch the trend of economic forces, resting in the optimistic conviction that when the cue is at last received it will stride upon the stage fully prepared to assume a leading part—to its own entire satisfaction.

Without dwelling upon this phase of this fascinating subject, the present article proposes to offer a birdseye view of the field of development activity, touching but slightly upon plant or construction details, and reviewing in a general way the technical press and the features of Southern water powers with which it has dealt. The plants considered are arranged roughly in the order of relative importance, as judged by the space accorded them by the technical press; the first group being plants completed, the second plants in process of construction, and the third plants begun during the year or about to be begun at this writing. The journals reviewed are the following: *Electrical Engineering, Electrical World, General Electric Review, Engineering News, Engineering Record, Power, Water Power Chronicle* and the *Manufacturers' Record.*

J. A. SWITZER, PROFESSOR HYDRAULIC ENGINEERING, UNIVERSITY OF TENNESSEE, AND HYDRAULIC ENGINEER, TENNESSEE STATE GEOLOGICAL SURVEY.

HYDROELECTRIC PLANTS COMPLETED.

On the proposed basis of classification, the Hale's Bar plant on the Tennessee River, built by the Chattanooga & Tennessee River Power Company, comes first. Construction on this plant was begun in October, 1905. On November 13, 1913, with much pomp and ceremony, its completion was celebrated. In the beginning, an allowance of four years of time and some four millions of dollars was thought to be ample for its completion. Eight years of work and some nine millions of dollars have actually been consumed in bringing the project to fruition. As an engineering accomplishment in the face of unforeseen difficulties, the plant is truly monumental. The added labor and expense have been due entirely to the difficulty of securing proper foundation, owing to the existence of innumerable seams and crevices in the rock formation upon which the lock, dam and power house stand. So thoroughly has the plant been written up that to describe it here would seem superfluous. Five complete articles have appeared concerning it during the year. One, a general description by the present writer, in the *Water oPwer Chronicle* for January; another by B. T. Burt, the company's resident engineer, in *Electrical Engineering* for August; and a third by an editorial writer in the *Electrical World* of November 15. An article devoted to the building of the foundations appeared in the *Engineering Record* of February 15, and another in much fuller detail in the *Engineering News* of November 13. The last named article is of great permanent interest, inasmuch as it contributes to engineering literature a full account of a notable engineering achievement.

The completion of this plant, located but thirteen miles from Chattanooga, creates an interesting situation in the power market of that city. For something over a year the city has been receiving power from the Parkesville plant of the Tennessee Power Company on the Ocoee River, which company owns the Chattanooga Railway & Light Company. At present there is no demand in the city for all the power which is now available, and so there is fine opportunity for the stimulation of new requirements. Although the unit development cost at Hale's Bar is very much higher than at Parksville, the published rates for the new power are lower. These rates are as follows: Primary demand charge, $1 per month per Kw. with a maximum demand based on a 7½-minute peak. The secondary service charge is: First 2,000 Kw-hrs., 1.5 cents; second 2,000 Kw-hrs., 1.25 cents; third 2,000 Kw-hrs., 1.0 cents; next 6,000 Kw-hrs., 0.75 cent, and all over 12,000 Kw-hrs., 0.5 cent.

On the basis of this schedule, a 300 Kw. demand installation with a consumption of 50,000 Kw-hrs. per month would cost $615.00; or 1.23 cents per Kw-hr. It is understood that the corresponding charge of the Tennessee Power Company would be $735.00, or 1.6 cents per Kw-hr. Thus, the Chattanooga & Tennessee River Power Company is underbidding the present market, nevertheless, it is limited in this direction to a greater extent than its rival by its higher capital cost.

The Hale's Bar installation is designed for 14 units of 3,000 Kw. each, of which 10 units are now in place, giving a plant capacity of 56,000 horsepower. The power output will be curtailed both by high water and by low water. From a river discharge of 17,000 second-feet up to 160,000 second-feet, the rated capacity will, on a 14-hour basis, be available. At 10,000 second-feet discharge, the available power will be but 16,600 horsepower; which, of course, means that an auxiliary plant will be an economic necessity. The company is reported to be actively planning such a plant with a capacity of 20,000 to 30,000 horsepower. The real value of the Hale's Bar plant will be greatly enhanced whenever the time comes that an effective system of flood control of the Tennessee River is made effective. Consequently, the plant will benefit from such storage as the power developments now built or projected upon the tributary streams will effect. The completed plants of the Tennessee Power Company on the Ocoee, of the Tennessee Eastern Electric Company on the Nolichucky and of the Watauga Power Company on the Watauga, begin this good work. The storage dam of the Tennessee Power Company on the Toccoa, the dams on the Little Tennessee soon to be built by the Aluminum Company of America, and the projected developments on the Clinch, the Powell and the French Broad Rivers, whenever actually built, will undoubtedly exercise an appreciable degree of regimentation of the Tennessee River itself.

With no blare of trumpets or beating of drums to announce the fact, the plant of the Georgia Railway & Power Company at Tallulah Falls, has practically reached completion, the first unit being placed in operation about the middle of September. In many respects this plant is notable. It is at once the highest head development, and with the exception of a development in Alabama not yet completed, the largest in the South. Designed for a capacity of 85,000 horsepower, it will actually develop 90,000 horsepower, under a head of 578 feet. The plant consists of an arch type dam, 110 feet high and 444 feet long; a concrete-lined tunnel 12 feet wide by 14 feet high, the length of which is 6,670 feet; a concrete-lined forebay excavated in solid rock, which serves as a surge-tank and measures 30 x 71 feet by 93 feet deep; six steel penstocks, with five installed, each 5 feet in diameter and approximately 1,200 feet long leading from the forebay, each through its own tunnel, down to a vertical shaft unit in the power house at the bottom of the river gorge.

Much interest attaches to the turbines. They were designed to develop 17,000 horsepower; and one of them, when tested at Holyoke, realized an efficiency of 87 per cent, and showed that under the head of 578 feet, 17,000 horsepower would actually be developed. The gratification of the makers, the S. Morgan Smith Company, then is apparent when on being placed in operation under the head of 578 feet, the units actually develop 18,000 horsepower, thus indicating a probable efficiency of considerably above 90 per cent. The plant is to be tested early in the year by Prof. Charles M. Allen, of the Worcester Polytechnic, and the outcome will be watched with interest.

As a part of the Tallulah Falls project, a storage dam is building on the Tallulah River, 6 miles above the power plant. This will store some 1,250,000,000 cubic feet of water, which represents about 20 million horsepower-hours, or enough storage to carry half the station capacity for 50 ten-hour days. Experience with water power development in the Eastern half of the United States is teaching, in no uncertain terms, that for the commercial success of a project, a large storage capacity is the *sine qua non.* A five-page article on this plant appeared in the September, 1912, issue of *Electrical Engineering*, and a two-page article by Mr. Murray Blanchard, of the Northern Contracting Company, in the *Water Power Chronicle* for January of this year, described the Tallulah Falls project. The issue of the *Engineering Record* for April 12, presents an account of the work of driving and lining the tunnel. The article is written by Mr. J. H. Graham, of Condon, Graham & Milner, the sub-contractors who built the tunnel. The most recent article is one appearing in the December 20 and 27 issues of the *Electrical World.*

Owing to the hardness of the rock and its abrasive character, great difficulty was experienced in drilling, blasting and mucking the materials. With reference to the placing of the concrete lining, it was found after considerable experimentation, that the best results were had and the most satisfactory progress made by the pneumatic method of mixing and placing the concrete. The concrete was conveyed from mixer to tunnel through an 8-inch pipe, being driven by compressed air, in some instances for a distance of 600 feet. The pneumatic placing resulted in a concrete of great density, secured without any hand tamping. Collapsible steel forms were used. The Tallulah Falls plant was designed and built by the Northern Contracting Co.

An interesting development is the Goat Rock plant on the Chattahoochie River, built by the Columbus Power Company. This plant went into commission on December 19, 1912. Articles describing the plant have appeared in the *Water Power Chronicle* for February and for April, 1913, and in *Electrical Engineering* for June, 1913, the latter article giving completely the engineering and electrical construction details. The Columbus Power Company owns or operates five power plants, three of which are water power stations and located within the city of Columbus itself. The Goat Rock development is located a few miles above the city and serves the double purpose of a generating station and a storage dam for the benefit of the plants located below it. The total present combined capacity, of the five plants is 17,850 Kw., and the ultimate capacity 40,350 Kw. The present installation at Goat Rock consists of two 3,750 Kva. units. Later these will be replaced by 5,000 Kva. machines, and as the market warrants, the power house will be enlarged to accommodate four more of the same size. The length of the dam is 1,212 feet, and of the spillway 910 feet, the effective head with flash boards being 73 feet. Since at this point the Chattahoochie River forms the boundary between the states of Georgia and Alabama, the plant is a truly interstate structure, the imaginary boundary line cutting it squarely in two. Besides the transmission of power to Columbus, to the south of the plant, power is also transmitted to the north to the towns of West Point, LaGrange and Newnan; and a large number of cotton mills and other factories are supplied.

On the 22nd day of August, 1913, the state of Missouri experienced the greatest hydroelectric thrill of its history. While it was not, perhaps, an 18,000 kilowatt thrill, it was due to the inauguration of what will be an 18,000 kilowatt development. On the White River in Southeastern Missouri, the Ozark Power & Water Company has built its initial water power plant, and on August 22 the plant went into commission. Descriptive articles have appeared in the *Water Power Chronicle, Manufacturers' Record, Engineering Record, and Electrical Engineering* for November. Of these the last is the most complete, and being so recent, will doubtless be fresh in the minds of all who read this article. The dam is 50 feet high and has a total length of 1,400 feet, of which 600 feet is an earth dyke with concrete corewall, 200 feet is power house, and 600 feet spillway. The spillway section is of the Ambursen type of dam, and together with the power house was built by the Ambursen Hydraulic Company. The ultimate equipment will consist of eight horizontal twin, S. Morgan Smith turbines and direct connected General Electric generators each of 3,600 horsepower capacity. But five units are being installed at present. The Ozark Power & Water Company is owned by the H. L. Doherty Company; and according to published reports, the power site developed is but the first of a series of six power plants to be built on the White River. A second is under construction on the James Fork of the White River, 100 miles above the power site. The plans seem to be quite ambitious, and if they are all carried out, will yield an aggregate of some 200,000 horsepower. The transmission line at present aggregates about 150 miles, and power is being delivered in Joplin and in Springfield.

Coming back to the Appalachian region, two more plants which have reached completion during the year demand mention. These are "Ocoee No. 2," which is the second development of the Tennessee Power Company on the Ocoee River, and the plant of the Tennessee Eastern Electric Company, on the Nolichucky. The second development of the Tennessee Power Company is located at Caney Creek, 9 miles above the Parksville plant. Water is diverted from the river by a 30-foot timber crib dam, and is carried in a timber flume a distance of five miles to the power house. The flume measures 14 feet 2 inches wide and carries water 10 feet 6 inches deep. It is laid with a grade of 5 feet per mile, being carried for the most part on a bench quarried out of the solid rock wall of the canon. Where the line crosses gullies and tributaries, the flume is carried on steel trestles. The capacity of the flume is 1,200 cubic feet per second. The flume terminates in a forebay from which the water enters the steel penstocks. The head on the plant is 250 feet. Two units each of 9,700 Kva. capacity have been installed, and provision is made for a third similar unit. The turbines are I. P. Morris, scroll case horizontal machines, direct connected to General Electric generators operating at 6,600 volts. Power is transmitted at 120,000 volts, on a standard steel tower transmission line. At present this plant is not tied in with the Parksville plant, from which power is transmitted at 66,000 volts pressure, but later the two will be brought together. Mention should be made in passing of the completion on May 9 of the 150-mile transmission line from Parksville to Nashville. On that date the load of the Nashville Railway & Light Company was assumed by the water power plant. The present output of the Caney Creek plant, 20,000 horsepower, is all sold to the Aluminum Company of America on a five-year contract, for use in that company's new reduction works now building near Knoxville. The plant, which went into operation on October 23, was built by the J. G. White & Co.

The plant of the Tennessee Eastern Electric Company on the Nolichucky River, 9 miles from Greeneville, Tenn., went into operation on the 28th of October. The plant is of excellent design, being fully abreast of the most modern hydroelectric practice. The dam has a present height of 39 feet, but later will be raised to 70 feet. Foundations for the 70-foot dam have been brought to a point just above low water level. An interesting detail is that the turbines will be adapted to the higher head by merely substituting new runners for those now installed. The turbines are vertical shaft, scroll case single runner machines, and were built by the Allis-Chalmers Company, although designed by Mr. W. V. N. Powellson. Mr. Powellson is chief engineer, and a principal stockholder of the Tennessee Eastern Electric Company. The installation will consist of four units which, with the 70-foot dam, will give a plant capacity of 16,000 horsepower. The two units now installed yield 3,600 horsepower. The generators are built for an output of 2,500 Kva. each, at 2,300 volts. The suspension bearings are at the top, and are self-lubricated. The entire equipment, turbines, generators and governors are of Allis-Chalmers manufacture. It is said that these turbines are the first to be built by this company fitted with steel scroll cases. Power from the plant is transmitted at 44,000 volts, over 43 miles of line, and furnishes the power requirements of Greeneville, Jonesboro and Johnson City. The office of the company is in Johnson City, and its general manager is Mr. Amzi Smith.

HYDROELECTRIC PLANTS UNDER CONSTRUCTION.

Here ends the enumeration of Southern water powers which, during the past year, have lifted their headgates for the first time. A fine array it makes, and a telling proof it furnishes of the rapid progress of the Southern water power industry. The year 1914 will add to the tale. Chief among the plants nearing completion is that of the Alabama Traction, Light & Power Company on the Coosa River. This plant is to furnish over 100,000 horsepower (the contract for four of six 13,500 Kva. units has been let), and early in the year the company will begin supplying the city of Birmingham with this power. A 15,000 horsepower steam plant has been built at Gadsden. This plant has carried a load for some six months, but will later be held as an auxiliary station. The plans of the Alabama Traction, Light & Power Company are sensational in the extreme. According to the *Electrical World* for April 12, and Sept. 13, and the article in this issue of *Electrical Engineering,* these plants contemplate the building of 11 dams, to develop 1,227,000 horsepower, and of some 230 miles of transmission line for its distribution. The dams are listed as follows: Coosa River Lock 7, of 45,000 horsepower; Coosa River Lock 12, of 105,000 horsepower; Coosa River Lock 14, of 100,000 horsepower; Coosa River Lock 15, of 180,000 horsepower; Coosa River Lock 18, of 100,000 horsepower; Tallapoosa River, Mussel Shoals site, 400,000 horsepower; Sautty Creek, 6,000 horsepower; Town Creek, 7,000 horsepower; Little River, 52,000 horsepower, and Choccolocco Creek, 2,000 horsepower.

Along about April, 1914, the wheels of the Augusta-Aiken Electric & Power Corporation will begin to turn and power be delivered to the city of Augusta. The 35-foot dam is being built by the J. G. White Company, and the ultimate capacity of the plant will be 30,000 Hp.

Early in the year, the City Water Power Company, of Austin, Texas, will complete its storage dam across the Colorado River. While built primarily for water supply, this dam renders available a moderate amount of power, and three wheels of 2,400 horsepower capacity are being installed.

Of the actual plants now under construction but not nearing completion, undoubtedly the most important and most interesting is that of the Southern Aluminum Company, on the Yadkin River, in North Carolina. An attractive general account both of the history of this project and of the new plans for its prosecution appeared in the *Electrical World* of March 15, and *Manufacturers' Record* for July 3.

The history of the project is unique. Some eight or ten years ago a company began to develop this water power. It built an immensely expensive masonry dam, and after nearly completing the project and having spent nearly $6,000,000, it failed. From an engineering standpoint, the plan of the development was ill-considered. It involved building, beside the dam, an expensive canal 4 miles long. The dam, which was but 35 feet high, gave practically no pondage on a stream subject to extremely wide variations of flow. Nevertheless, when the Southern Aluminum Company took the project over, the first plan was to complete the work along the original lines. Contracts for this completion and for the equipment of the power house were closed. The entire plan was then changed, the contracts cancelled and the use of the masonry dam and the canal definitely abandoned. Instead, a dam 200 feet high is to be built just below the site of the original power house, and the pool which this dam will create will completely submerge the old dam and, with an area of 6,000 acres, will afford a very respectable storage capacity. Actual construction began in April and will continue for two years.

Nothing could illustrate more concretely than does the history of this development the advancement in hydroelectric practice brought about during ten years just past. Ten years ago, the present scheme would scarcely have been regarded as sane. It would have outstripped experience and hence would no doubt have received but scant consideration. Today is typifies the achievements of hydraulic engineering in the year 1913. The contract for this work was awarded to the Hardaway Contracting Company, of Columbus, Ga. The dam will be 1,300 feet long and will contain 360,000 yards of cyclopean concrete. The power house equipment will consist of sixteen 5,200 kilowatt units. As the power is to be used in smelting aluminum, these will generate direct current at 550 volts. In point of size, the generators will be the largest ever built.

This article should not close without devoting a brief space to one other important development on which construction will shortly begin. This belongs to the Aluminum Company of America, and is located in Tennessee and North Carolina.

For nearly two years a large field party has been making the preliminary examination of the power possibilities of the Little Tennessee River. The Aluminum Company of America purchased the rights of the Knoxville Water & Electric Power Company on the Little Tennessee. At first, nothing more was contemplated than the single moderate head development which that company had in prospect. Due mostly to the large vision and the persistence of the engineer in charge of the field operations, Mr. R. S. Peotter, however, the horizon of this project gradually expanded, until now it includes the entire power potentialities of the Little Tennessee and all its tributaries. Five dams are to be built, and contract will be let for the first dam, probably within a very few months. This dam will be located a few miles below the state line in Tennessee. It will be approximately 200 feet high, and will develop about 85,000 horsepower. Probably before this plant is finished the second, which will be quite similar, and about 6 miles from the first, will be started. At the present time a large force of men are at work stripping for the foundations of both dams, and exploring the underlying strata with diamond core drills. These two dam sites, with which the writer is fairly familiar, are particularly well adapted for the location of such high dams. At the second dam site, the river is but 200 feet wide at the present water line, and so steep are the abutting canon walls that the length of the arch-type dam will be but 890 feet at the crest, and at the first site the dimensions are nearly the same.

The unit cost of the developments (which it is claimed will be for an ultimate capacity of 400,000 horsepower), will undoubtedly be quite low. It is believed that most of this enormous block of power will be used in the smelting and refining of aluminum. The manufacturing facilities of the Aluminum Company of America at the present time are inadequate; and so rapidly is the demand for aluminum growing that the need of new sources of power is keenly felt in the industry. At one time the company gave serious consideration to plans for a hydroelectric development on the St. Lawrence River, in Northern New York, but a perpetual franchise to the power site could not be obtained, and it is probably for this reason that the company turned its attention to Southern power possibilities, with the result already noted.

These, then, are the chief power developments, whether completed, in progress of building, or projected for immediate construction in the South. Several other large developments, such as that of the Virginian Company in West Virginia, might be listed, but upon careful inquiry it cannot be definitely learned that any of these are ready for construction work to start within the next six months, and hence they are not included.

In order to give a clear view of Southern progress in water power development in the briefest possible space, the following table has been compiled. We cannot claim infallibility for its contents; nevertheless, every reasonable effort has been made to verify the information given, and to include every power project of importance which is not merely a speculative scheme with no purpose behind it:

IMPORTANT SOUTHERN HYDROELECTRIC PLANTS—COMPLETED, UNDER WAY AND PROPOSED.

Name of System and Territory Served.	No. Plts.	Present Capacity in K. W.	Ultimate Capacity in K. W.	Miles of Line Constructed	Financed by
NORTH CAROLINA.					
Southern Power Co. N. & S. Carolina	5 H 3 S		206,000	1250	Dukes (Cap.
Sou. Aluminum Co.	1	40,000	120,000		Dukes & French
Carolina Pr & Lt Co.	3 H 2 S	34,000		220	Elect. Bond & Share Co.
Yadkin River Pr. Co.	1	32,000		120	Elect. Bond &
Manufacturers Pr Co.	1		37,000		Share Co.
N. C. Elect. Pr. Co.	3	8,000	20,000	80	Local Capt.
Asheville Pr.&Lt. Co.	3 H 1 S	1,250	5,000		Elect. Bond & Share Co.
Carolina-Tenn Pr.Co.	1	50,000			
Piedmont Ry. & Elec. Co.	1	2,500	5,000		
Proposed.					
Raeford Pr.& Mfg.Co.	1	750			
United Pr. Dev.Co.	1	35,000			
Va.-Carolina Pr. Co.	1	20.000			
Thornton Dev.	1	6,800			M. E. Thornton.
Carmichael Dev.	1	20,000			W. C. Carmichael.
SOUTH CAROLINA.					
S.C. Lt. Pr. & Ry Co.	1	9,000	26,000	63	
Parr Shoals Pr. Co.	1	18,000	24,000	20	J. G. White Co.
Anderson Wtr. Lt. & Pr. Co.	1	5,500	15,000	10	W. S. Lee.
Ware Shoals Mfg. Co.	1	2,700			Local.
Union Mfg. Co.	1	6,000			Local.
Tucapau Mills	1	2,000	3,500		Local
Pacolet Mfg. Co.	1	2,200			Local.
Pelzer Mfg. Co.	1	4,800	6,000		Local.
GEORGIA.					
Ga. Ry. & Pr. Co.	3H 2 S	100,000	350,000	125	Local.
Augusta-Aiken Ry. & Elect. Corp.	1	13.500	30,000	27	J. G. White Co.
Cent. Ga. Pr. Co.	1	12,000	18.000	100	A.B.Leach & Co.
Columbus Pr. Co.	3H	18.000	40,000	80	Stone & Webb.
Wofford Shoals Co.	1 S	100	12,000	10	Local.
Athens Ry. & Elec. Co.	3H 1 S	6,700		25	H. L. Doherty
FLORIDA.					
Florida Pr. Co.	1	3,300	9,000	45	Local.
ALABAMA.					
Ala. Traction, Lt. & Pr. Co.	2H 1 S	68,000	1,227,000	100	London cap.
Tallassee Falls Mfg. Co.	1	4,300			Local.

MISSOURI.					
Ozark Pr. & Wt. Co.	1	13,500	28,800	150	H. L. Doherty.
Empire Dist. Elec. Co.	1H 1 S	15,000		100	H. L. Doherty.
ARKANSAS.					
Garland Pr. & Dev. Co.	1		21,000	30	Local.
Mammoth Sp. Lt. & Pr. Co.	1	2,200	30,000	34	Memphis, Tenn. Interests.
Proposed:					
Dixie Pr. Co.	1	10,000			
N. Ark. Pr. Co.	1	1,000		30	
TENNESSEE.					
Chat. & Tenn. Rvr. Pr. Co.	1	31,300	43,863	33	N. Y. Edison.
Tenn. Pr. Co.	2	38,000	150,000	300	H. M. Byllesby and others.
Watauga Pr. Co.	1	2,400	3,600		H. L. Doherty.
Tenn. East'n. Elec. Co.	1H 3 S	7,000	16,000	43	
Proposed.					
French Broad Rvr. Pr. Co.	1	22,000			
Alum. Co. of Am.	4	200,000	400,000		
Tenn. Hydroelectric Co.	5		400,000		Pittsburgh cap.
WEST VIRGINIA.					
Virginia Pr. Co.	1H 1 S	115,000	170,000	200	A. B. Leach Co.
W. Penn. Tract. & Wt. Pr. Co.	1	36,000	100,000		Kuhn Interests.
Martinsb'g Pr. Co.	2	1,500			
Proposed:					
Tri-State Pr & Mills Co.			45,000		Local.
VIRGINIA.					
Va. Ry. & Pr. Co.	2H	16,000	21,000		Gould Interests.
Va. West'n. Elec. Co.	2H 1 S	1,800	10,000	12	
Appalachian Pr. Co.	2H 1 S	28,000	55,000	50	H. M. Byllesby.
Emporia Hydroelect. Corp.	1	1,800	4,000		
Fredercksburg Pr. Co.	1	3,000			
Lynchburg Wt. Pr. Co.	1	3,000	8,200		
Roanoke Tract. & Lt. Co.	1	2,200	3,700		
RoanokeRapids Pr Co.	1	3,000	6,000		
OKLAHOMA.					
Bettes Pr. Co.	1		3.800		
Proposed:			20,000		
Muskogee Wt. Pr. Co.	3				
Campbell Dev.	1		30,000		

H indicates water power station; S indicates steam station.

Some Important Hydroelectric Developments on the Pacific Coast

(Contributed Exclusively to Electrical Engineering).

BY ROSS B. MATEER, E. E., COMMERCIAL AGENT, THE SOUTHERN SIERRAS POWER COMPANY.

The Electrical Development Work of Southern Sierras Power Company, the Pacific Light & Power Corporation, the Pacific Gas & Electric Company and Los Angeles Municipal Aqueduct.

THE year nineteen hundred and thirteen has witnessed a decided progress for the electrical industry. Only a few years ago, hydroelectric developments were considered necessary for manufacturing purposes, mining and kindred industries. Today the demand for current, for agricultural purposes and the sudden awakening of central station managers to the value of such business has resulted not only in the enlargement of existing plants, but in the erection of new structures, the installation of large generating units and the construction of miles of steel towers carrying aluminum conductors transmitting energy at high voltage to distant substations. Among projects recently completed and now in operation in the Pacific states are those of the Southern Sierras Power Company, the Pacific Light & Power Corporation, the Pacific Gas & Electric Company's Lake Spaulding development, and the Los Angeles Municipal Aqueduct.

THE SOUTHERN SIERRAS POWER COMPANY.

Appreciating the market for power created by the sensational discovery of gold in Southwestern Nevada in 1904, a group of capitalists sought to develop the nearest dependable water power, which was on Bishops Creek, a tributary of the Owens River in Eastern California and over one hundred miles distant. A company was organized, water rights were secured, and in 1905 a power house, now known as No. 4, was erected and a transmission line was built into the rich mining district in the vicinity of Goldfield and Tonopah, Nevada. At first 1,500 kilowatts were installed, but the development of additional territory in Nevada soon warranted increasing the power plants by the addition of 4,500 Kw. This was ample then to supply all the demands for power in the mining district, yet not sufficient to utilize the ultimate development possible on Bishops Creek. Knowing that as the rich high-grade ore was removed and only low-grade dirt encountered, the demands for power would decrease, another market, wherein to dispose of all electrical energy in excess of that required in Nevada and which might be developed by a series of power plants so arranged as to utilize the entire fall of Bishops Creek, nearly 5,500 feet in its travel of 14 miles, was sought.

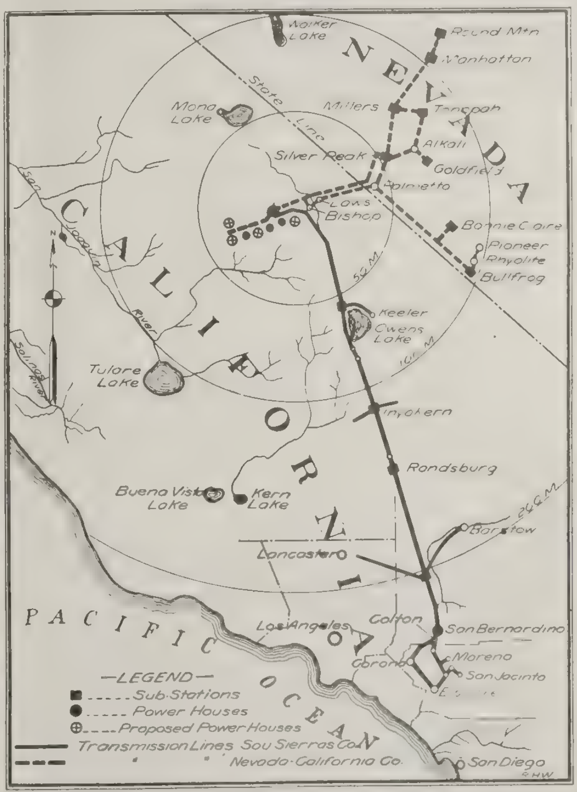


FIG. 1. MAP SHOWING POWER STATIONS AND TRANSMISSION LINES OF SOUTHERN SIERRAS POWER COMPANY AND NEVADA-CALIFORNIA POWER COMPANY.

That portion of California lying between the Sierra Nevada Mountains, the California-Nevada state line, and extending south to and including the northern portion of San Diego county, presented a territory possessing a soil capable of producing untold wealth, provided water were supplied. Realizing the demands for power when the 30,000 square miles were placed under cultivation, it was determined to erect additional generating plants and construct a transmission system through the apparent desert lands, tapping the rich fruit belt in Riverside county. A second corporation, the Southern Sierras Power Company, and financed almost entirely by the parent corporation, the Nevada-California Power Company, was formed. Three power plants, Nos. 2, 4 and 5, of 9,500-kilowatts, were placed in operation in 1908, 1905 and 1907, respectively, and two additional hydroelectric stations, known as Nos. 3 and 6, of 6,750 and 2,000 Kva. were completed the past year.

GENERATING STATIONS.

Reinforced concrete structures, designed to give a maximum of strength and efficiency with a minimum of material is characteristic of all but one of the generating stations, namely, No. 5. Station No. 3, the most modern plant, is 38½ x 82 feet inside dimensions, has five pilasters, including corners on each side and two on each end, and very similar to station No. 2. The roof is supported on Fink trusses, and is of galvanized corrugated iron. The three main generating units, each of 2,250 Kva. and of the two bearing type, generating three-phase current at 2,200 volts, were designed and built by the Crocker-Wheeler Company, of Ampere, N. J. They are driven by single overhung runner water wheels designed and built by G. T. Henry, of San Francisco. As the variation in water flow is slight and the operation of the plants in series preclude a sudden change in the quantity of water, it is the policy of this company to eliminate all automatic regulating devices on the hydraulic and electrical parts of the system, and therefore the stationary needle nozzles of the wheels are controlled by hand.

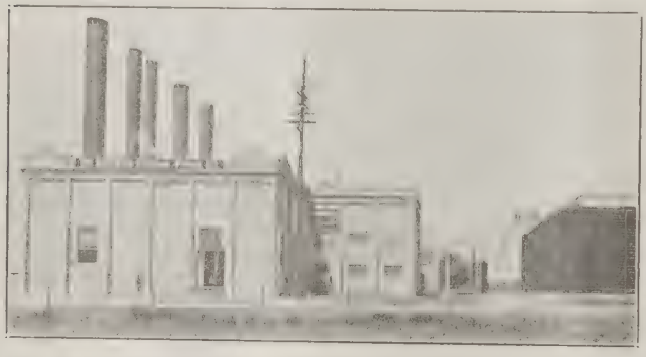


FIG. 2. STEAM STATION OF SOUTHERN SIERRAS POWER COMPANY.

Two exciter sets, close to the wall of the building, are in line with the switchboard. The generators are six-pole, interpolar, and designed for 125-volt, direct current when operating at 850 rpm., and are driven by single runner overhung water wheels, with hand-controlled nozzles. Flexibility is provided by equipping one exciter with a 3-phase, 2,200-volt, 150 Hp. induction motor. The motor is placed between the generator and wheel, yet connected to the water wheel by a bolted coupling.

The switchboard of five panels was a part of the contract entered into with the Crocker-Wheeler Company for power house equipment. The panels were equipped with Westinghouse instruments, conduit oil circuit-breakers, including time-limit relays and automatic trips, which are, however, not in service, it being the policy to avoid all automatic devices.

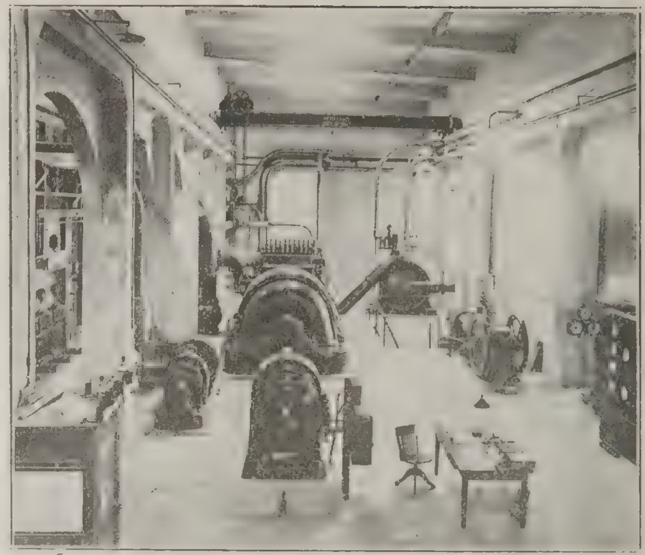


FIG. 3. INTERIOR VIEW OF STEAM STATION OF FIG. 2.

Adjacent to the power house are three Westinghouse out-door type water-cooled transformers, designed for raising the impressed voltage from 2,000 to 87,000 or 150,000 volts. Over each bank of transformers is a steel frame on which are mounted the disconnecting switches of the Bowie air-break type.

Station No. 6, completed in March, 1913, contains one 2,000 Kva. Allis-Chalmers unit, designed for a speed of 164 rpm. An exciter of 50 Kw., 125 volts, direct current was supplied by the Allis-Chalmers Company, and operates either from a two runner needle nozzle water wheel or from a 60 Hp. 2,200-volt induction motor of 860 rpm. The standard type of switchboard adopted by the Southern Sierras Power Company completes the interior equipment of this station. Near the power house is the standard outdoor construction for disconnecting switches and three 750 Kva. Westinghouse transformers, of the out-door type.

Realizing the value of auxiliary steam generating apparatus, a suitable structure was constructed at San Bernardino, Cal., and houses two steam driven turbine units. One of 5,000 Kw. capacity, designed by the General Elec-

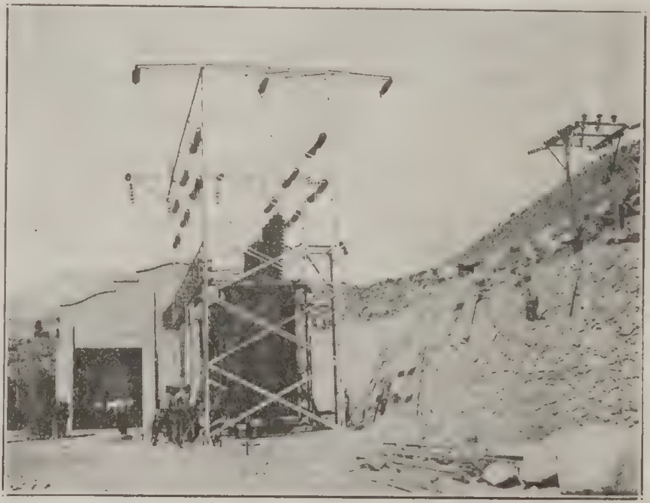


FIG. 4. HYDROELECTRIC STATION NO. 3 OF SOUTHERN SIERRAS POWER COMPANY.

tric Company, to operate at 180 pounds steam pressure, and another unit designed by the Allis-Chalmers Company consists of a turbine and generator of 5,000 Kw. capacity. Current is generated at 6,600 volts.

TRANSMISSION SYSTEM.

Double circuit steel towers of a type generally adopted by the large hydroelectric companies were used for the 238 miles of transmission line from the control station at Bishops Creek to San Bernardino. All the towers were anchored in concrete as is customary where severe windstorms and ærial disturbances are experienced. Actual engineering data as to the physical characteristics of the system is to be obtained from Messrs. Manifold & Poole, consulting engineers, of the Southern Sierras Power Company, and to whose careful investigations of conditions to be overcome is due much of the success of this system, a pioneer of its kind and successfully transmitting power at 150,000 volts over desert and range to the rich valleys in Southern California. Aluminum steel cable of seven strands, six of aluminum and one of steel, is used for the high tension transmission system.

Unique features of this development are, the control stations, one at Bishops Creek Canyon, from which is governed those circuits feeding from the power houses to the transmission system. The out-door substations located along the transmission system and for reducing the voltage for distribution purposes at Lone Pine, Inyoken, Randsburg, Victorville and San Bernardino, are equipped with out-door type transformers, standard pole top Bowie air-break switches arranged for either hand operation or by compressed air.

The conservation of the water to obtain power without waste. After leaving the storage reservoir, the water is carried successively from the tail-race of one station to the intake of the next, through redwood stave pipe, and does not follow its natural course until it has passed through the wheels of the last plant.

THE BIG CREEK DEVELOPMENT OF PACIFIC LIGHT AND POWER COMPANY.

In 1911 the Pacific Light & Power Company began work on its new hydroelectric development known as the Big Creek system. The location, design and construction of three arched concrete dams, each of gravity section and of 139½, 85 and 130 feet in height, respectively, create a huge lake 4½ miles long and ¾-mile wide, of 45,000 acre-feet and ample to develop 84,000 horsepower at a load factor of 50 per cent for a period of 180 days without flow in from streams or other sources. By the addition of 50 feet to the present embankments the storage capacity will be increased to 110,000 acre-feet, draining an area of 80 square miles, ranging between elevations of from 7,000 to 12,000 feet, and in which the annual precipitation varier from 80 to 150 inches.

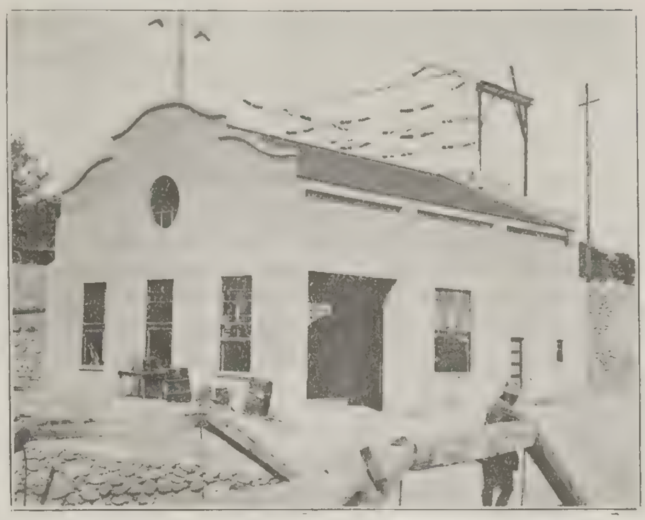


FIG. 5. HYDROELECTRIC STATION NO. 6 OF SOUTHERN SIERRAS POWER COMPANY.

From the lake the water passes through a granite-rimmed pressure tunnel 4,000 feet long and 12 feet in diameter, then by 6,500 feet of 84-inch steel pipe to a hill where the flow line divides into 4 pressure lines, two of which are for the plants now installed, the others for future development. The steel pressure pipes are 44 inches in diameter at the top and converge to 24 inches at the bottom and of an ever increasing thickness, consistent with the increasing water pressure, until at the point of maximum pressure a

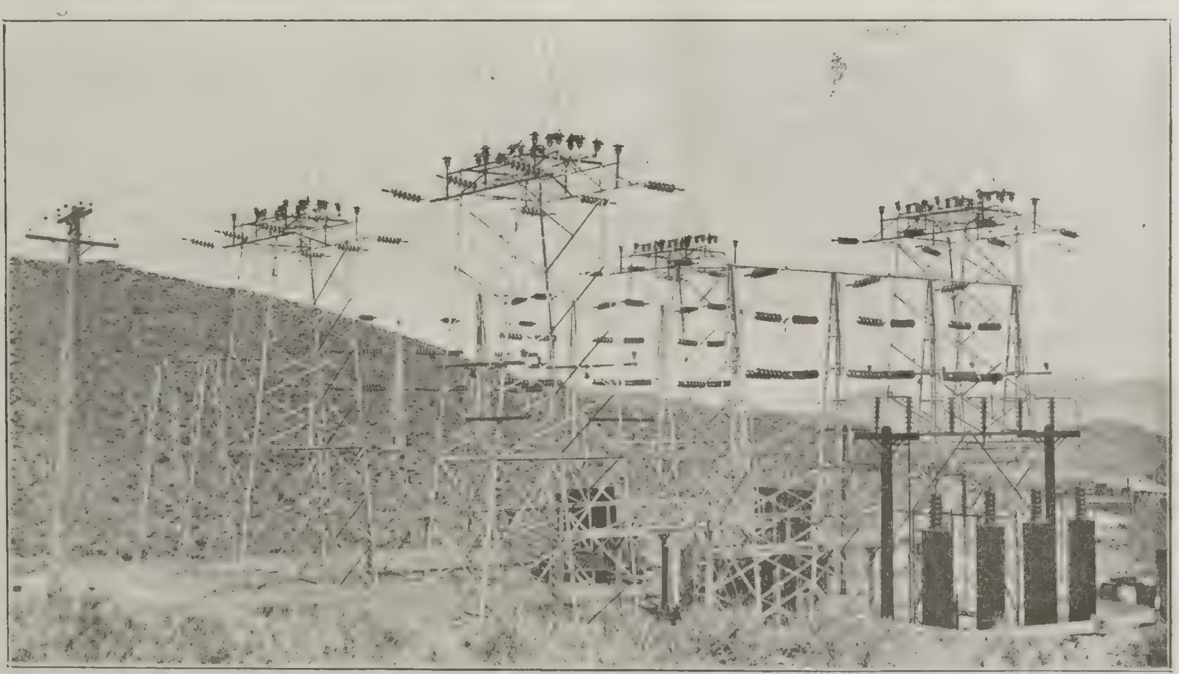


FIG. 6. RANDSBURG SUBSTATION OF SOUTHERN SIERRAS POWER COMPANY, SHOWING TYPICAL OUTDOOR CONSTRUCTION

thickness of 1 inch is attained. At the lower end of the pressure pipes are hydraulically-operated valves designed for a water pressure of 1,000 pounds to the square inch, and which control the emission of water to the wheels of the impulse type, and driven by a nozzle of 5½ inches diameter. Through the nozzles, one to each wheel, the water issues at a velocity of 300 feet per second, generating 10,000 horsepower. Two generating plants are at present in operation, each consisting of two units of 20,000 Hp. Each unit is equipped with two water wheels of the impulse type, each wheel guaranteed for 10,000 Hp. The generator is mounted in the center between the wheels.

From power house No. 1, which is equipped throughout with General Electric apparatus, the water passes to a tail-bay. From the tail-bay the water flows through a granite tunnel, 22,000 feet long and 12 feet diameter, to a circular forebay, necessary by reason of the fluctuations in load and the accelerating inertia of the moving water in the 4-mile tunnel. From the forebay the water is carried through pressure pipes similar to those previously mentioned, to generating plant No. 2, which is equipped throughout with Westinghouse apparatus. The total difference in elevation between the lake and discharge channel is 4,000 feet, or 2,000 feet head for each of the present generating plants.

The transmission line carries steel-cored aluminum conductors approximately 1 inch in diameter, arranged in a horizontal plane on suspension type insulators and steel towers, 421 miles, to the Eagle Rock Substation near Los Angeles. It is generally conceded to be the longest straightaway transmission system, without tap lines, ever constructed for a voltage of 150,000. The longest span is 2,700 feet and is necessary at the King River crossing. Eight million pounds of aluminum were used in the construction of the double transmission lines.

Prior to actual construction work on the dams and power houses, it was necessary to build 56 miles of standard gauge railroad through a country presenting obstacles at every turn. Such a task, that of locating the line, purchasing the right-of-way and building a railroad, of which it is said no successive twenty feet follows a straight line, was accomplished in the short period of five months. The line has carried 75,000 tons of freight since its construction.

LAKE SPAULDING DEVELOPMENT.

Lake Spaulding, the new storage basin now nearing completion by the Pacific Gas & Electric Company, is created by the erection of a concrete wall, ultimately of 325 feet in height, but now of 225 feet, across the mouth of a canyon far up in the range and conserving the normal flow and flood water of the South Fork of the Yuba River. The lake so created will have a drainage area of 120 square miles, the water shed of which area contains 22 small lakes, the spill wasted waters of which are all controlled by the one large reservoir. The capacity of the present lake is 44,000 acre-feet, although ultimately 97,000 acre-feet or 30,000,000,000 gallons, sufficient for a continuous discharge of 350 second feet, will be stored back of the concrete wall, 246 feet thick at the base, rising to a height of 325 feet and containing some 320,000 yards of masonry, while 55,000 cubic yards were required for the spillways only.

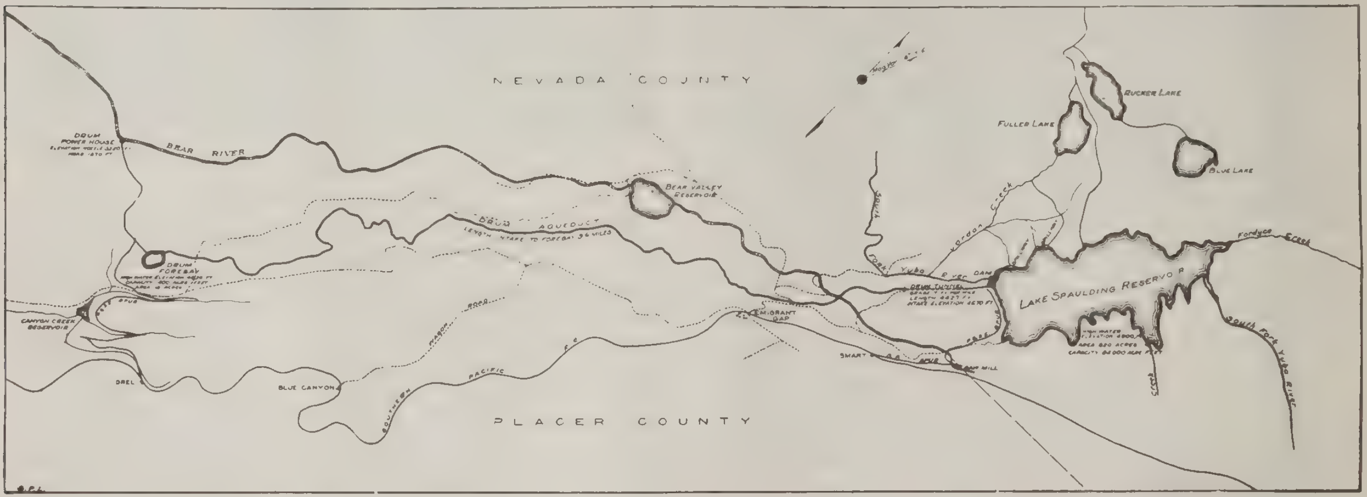


FIG. 8. THE LAKE SPAULDING RESERVOIR AND DRUM AQUEDUCT FOR DRUM POWER DEVELOPMENT OF PACIFIC GAS & ELECTRIC COMPANY.

Actual placing of concrete began October 28, 1912, and except for inclement weather has continued without interruption at the rate of 200 cubic yards per hour, or 1,306 cubic yards per day until completed to its present heighth of 225 feet at an elevation of 4,825 feet. Four Smith mixers, each of one cubic yard capacity and a perfect gravity system permitted a maximum of 2,150 cubic yards of concrete poured on August 18, 1913, said to establish a world's record for construction.

Water will be drawn from the reservoir through two intake pressure tunnels, concrete lined and of 8 feet, 8 inches inside diameter. One intake is at an elevation of 4,770 feet, the other 100 feet lower. Each tunnel is equipped with a separate gate valve permitting the use of either one as a source of supply. Leaving the lake the water is carried by 3,358 feet of tunnel 9½ feet in diameter and by open canal 8½ miles to the forebay, a large regulating reservoir of 400 acre-feet capacity and formed by gouging out the top of a hill. From the forebay a steel pressure pipe 72 inches in diameter and ⅜-inch thick at the top and tapering to 52 inches diameter and 1¼ inches thick at the bottom, or point of maximum water pressure, and of 6,214 feet in length delivers the water under a head of 1,375 feet to the double overhung Pelton-Doble impulse wheels, each driven by a single deflecting 6⅞-inch nozzle. After discharging into the tail bay, the water will be carried a distance of 8½ miles to a second power plant where a fall of 826 feet is possible and 33,250 Hp. may be generated, then by canal a distance of seven miles to plant No. 3, where with a drop of 500 feet some 20,000 Hp. may be generated. Leaving the tail bay of the last plant, the water is carried about one mile through the Bear River channel and then diverted through canals for irrigation purposes in Placer and Sacramento counties, California.

THE DRUM PLANT.

At the present time only the first generating plant is being completed, known as the drum plant. Two 12,500 kilowatt units, each consisting of revolving field type generators, divided horizontally and keyed to a horizontal shaft, driven by two 9,000 Hp. overhanging impulse water wheels, are now in place. Current generated at 6,600 volts is fed direct through low tension switches to six 4,250 Kva. transformers and stepped up to 125,000 volts. From the transformers a new transmission system consisting of 731 steel towers, with suspension type insulators and provided for two circuits, will carry the current 114 miles west to the Cordelia substation. From there current will be fed into the present lines linking the bay counties, at a potential of 60,000 volts.

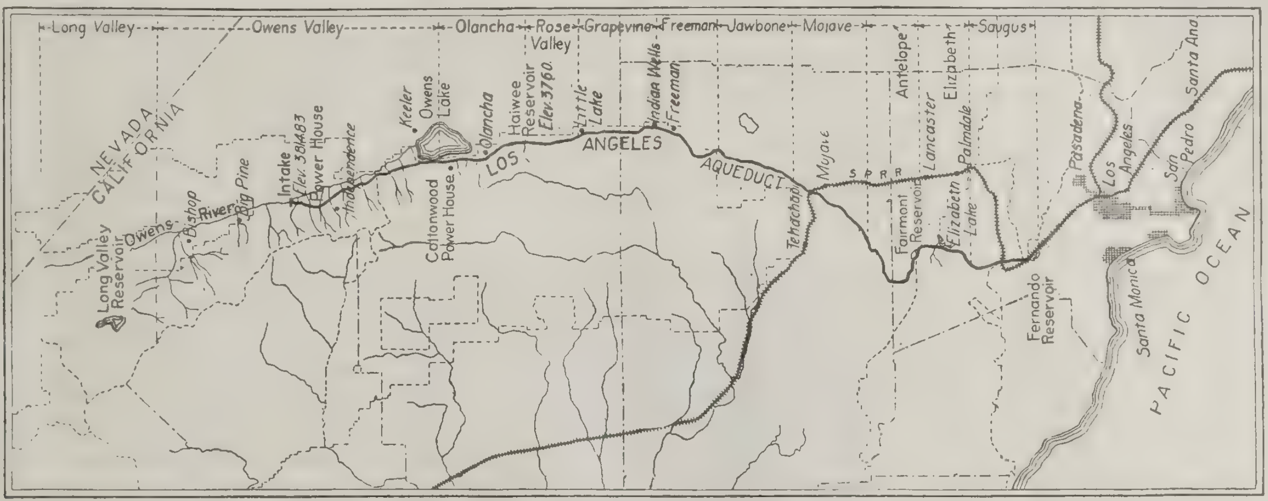


FIG. 9. MAP SHOWING ROUTE OF LOS ANGELES AQUEDUCT.

While at present but two units are installed, the ultimate development of the drum power house will consist of 40,000 kilowatts or 53,000 Hp. which, with the contemplated five additional plants, will insure an ultimate development of 152,000 Hp. from the storage basin now in service.

THE LOS ANGELES MUNICIPAL AQUEDUCT.

In 1904 the water commissioners of Los Angeles, Cal., determined to seek an additional source of water supply, such as would be ample for the needs of the city for many years to come. In 1905 a solution unsurpassed in magnitude was suggested to the authorities. It was proposed to utilize the floods of water that pour down the sides of the Sierra Nevada Mountains and were lost in Owens Lake, a dead sea of the Inyo desert, as a never-failing supply of water for the city. some 250 miles to the south. Surveys were made; a constantly descending route over desert and through mountain range was located; lands controlling water rights and suitable for reservoir sites along the Owens River were acquired; the cost of constructing canals, tunnels, siphons and storage basins were determined, and in 1905, $1,500,000 of bonds were voted to purchase the lands and riparian rights. In 1907, $25,000,000 of bonds were authorized for the actual construction of what is the greatest aqueduct in modern history, and on November 5, 1913, water was actually delivered from its source 250 miles northward, to the San Fernando reservoir at the gates of Los Angeles.

A survey of the work shows an intake on Owens River at a point about 35 miles north of the junction of the river and Owens Lake; a canal of 900 second feet capacity 60 miles in length through Owens Valley, to Haiwee reservoir, 200 feet higher than Owens Lake; from Haiwee to Little Lake, 15 miles of conduit, lined and covered and of a capacity of 410 second feet; 24 miles of conduit, tunnels and siphons to Indian Wells; 20 miles of conduit, flume and siphon to Red Rock Summit; 19 miles of similar construction through "bad lands" to the Mohave desert; 68 miles of concrete conduit through the desert to Antelope Valley; 15 miles of tunnels, siphons, flumes and conduit to San Fernando reservoir, or a total of 225 miles, exclusive of the Fairmount reservoir, the Elizabeth lake tunnel of 25,000 feet, and the power drops to San Francisquito canyon. Roads were built through the desert, a cement mill designed for a capacity of 1,000 barrels of Portland cement per day, was constructed; power plants to generate power for construction purposes were erected, 218 miles of transmission and 337 miles of telephone and telegraph line were built that the work might progress at a rate that would insure its completion within the time limit, 5 years, and within the appropriation of $25,000,000.

CHARACTERISTICS.

Among the unique features of this project were the tunnels, the reservoirs and power developments. The Elizabeth Lake tunnel, 26,870 feet in length and 10 x 12 feet in diameter, and with a capacity of 1,000 cubic feet of water per second, was hewn out of hard rock, and with construction gangs at both portals, was built at the rate of 22 feet per day. Another tunnel was known as Red Rock, and was driven 10,596 feet through sandstone at an average estimated cost of $8.26 per foot per excavation, and $6.12 per foot for lining.

POWER GENERATION.

While providing for domestic consumption and for irrigation purposes in the vicinity of Los Angeles, it was proposed to utilize a portion of the flow for the generation of power, sufficient to supply the municipal lighting system. With this in view, two drops of 1,500 feet and with a maximum flow of 1,000 cubic feet per second, are to be used in San Francisquito Canyon for the development of approximately 45,000 Hp., the other developments possible along the aqueduct will permit of a maximum of 72,000 Hp., to be utilized for municipal purposes, both present and future. Bonds for the completion of power plants and for the acquisition of a distribution system by purchase or construction are now pending.

The Holding Company and Its Part in Central Station Progress

(Contributed Exclusively to Electrical Engineering.)

BY GEORGE WILLIAMS.

IT would be a rather difficult matter at the present time to find a patron of a syndicated utility company who would prefer to go back and buy service from a former company that supplied it under the old-time, independent conditions of management. The preference of the investor for shares in a group of scattered companies rather than for the stock of one local company is apparent and well known. The economies resulting from purchasing power for plant equipment are natural, but it may be of interest to review some of the causes of the evolution which has taken place in recent years, and is grouping the larger portion of the gas, electric and traction interests in this country.

GEORGE WILLIAMS, OF H. L. DOHERTY & COMPANY, NEW YORK CITY.

Years ago it was not unusual to find a public service plant owned by an individual, sometimes by a number of local capitalists, perhaps a bank, or by a number of local merchants. Great respect is due all of these men who pioneered these new industries. In most instances, however, they were unfamiliar with either the scientific or practical operation of plants and many examples exist where these men risked their capital, not so much with the view of making money directly, but of meeting the problem of supplying their communities with gas, electricity and street car service.

With the march of civilization, the growth of communities and the tremendous increase in demand for central station service, these utilities required vast amounts of capital with which to provide their towns with adequate service. Foreign ownership was thus made necessary because the citizens were not informed as to how, or able to finance their companies. Then came the time when corporations themselves were being consolidated, and now the plant in many a small town is owned by thousands of small stockholders whose residences are scattered over the whole world. In other words, "syndicate ownership" means that where there were a dozen stockholders in the gas or electric properties of a town a few years back, there may now be twelve thousand.

The gas and electric industries have undergone a parallel evolution. This is an age of specialists, and the growth of these industries along the most successful lines demands the attentions of specialized ability in every phase of development, thus there are more positions to fill than there ever were before. The companies themselves which a few years ago may have ranked as comparatively small in local importance, have expanded and grown to be leading factors in civic development, largely due, we can truthfully say, to a careful analysis of conditions of both operation and management.

The process of syndication is as certain as the law of gravitation, for every unbiased mind will recognize that the grouping of public service properties is just as normal and beneficial as the grouping of the many railroads that at one time connected New York with Chicago. That these consolidations should be successful is logical. The investment is safer, the service is improved and made more accessible to more people and for more purposes. The price of the product itself is lower and the service given with it multiplies the usefulness of the product to the purchaser.

It may now be logically asked, "What is bringing all this about, and what were the general conditions?" Well, before the day of the "holding company" or the "syndicate," the majority of readers will recall in their towns that the gas and electric companies tal tied up in them. The service tremendous amount of local capi- looked then as though there was a what they are today—although it were small concerns compared to was unreliable, the price for it much higher than now, and few towns of under five thousand inhabitants had electricity, and the officers of these companies possessed less general information about gas and electricity and the possible uses than many of their customers possess today. There may have been lighting facilities, but the towns were dark. The company showed little interest in the customer, and less in his service equipment, and very little if any interest was taken by the company in the civic features of the community.

Then, along came the promoter, and the company was purchased by a "holding company." Adequate plants and equipment were provided; production was carried on, on a larger scale, and gas and electricity placed at the disposal of manufacturers under such methods that they in turn have revolutionized their production by it. Further, nearby towns and suburban sections have been metropolitanized as a result of this central station expansion, and the uses for gas and electricity multiplied, while the cost of service has been reduced. Street illumination has increased, and the shopping district transformed into a place that draws people and trade. The company's operations have brought new life, activity and talent to town. Its offices have taken a prominent location and the company is a leading contributor to public movements. It is a large taxpayer, carrying its share of the burdens of the town, its payrolls have doubled or trebled, and the company has become a leading factor in all community progress. You have observed all this in your own town, or some adjacent town, if you live in America.

It is not money alone that has brought about these conditions; it is a combination of money, talent and optimism. The pioneer organizers of the "holding company" were men who excelled in the management of small properties. They possessed superior talent and an ability to develop organizations of specialists. They represented, in the gas and electric industries, a parallel element to those who founded the great industries which have made this country supreme. They were optimists because they have seen and still see more opportunities for new and greater uses of gas and electricity than the large majority of men in this business ever before dreamed of.

The "syndicated organization" has the natural facilities for developing and specializing talent which seems to be impossible in an independent concern. It can secure and afford the best brains in the business, discover the best methods and processes of merchandizing, and has the facilities for comparative accounting and details for comparative management. The "syndicated company," in fact, is akin to a great university as a training school.

In what has been said, it must not be inferred that the writer claims it is impossible for an isolated company to attain high efficiency, for some are in excellent condition and well operated. Neither does he claim that every syndicated group of properties will succeed, but he does claim that the possibilities of any single company are incomparably greater after it becomes allied with other properties. There are a tremendous number of sewing machines, talking machines, automobiles, insurance policies, five and ten-cent articles, magazines, etc., sold in every city. There may be, here and there, men who have inexperience and nerve enough to build plants to supply the local needs for these things, but the universal investor is shy on these enterprises. He demands organization, an average of results, and a distribution of risks. That great purchaser, "the public" has, therefore, made successful the cigar stores, five and ten-cent, theatrical, newspaper, and every kind of syndicate, because of the ability of these organizations to render a preferable service. There has always been opposition to inevitable progress; there always will be. There have always been big politicians who thrive on their ability to agitate public discontent, and they will always have small imitators who will attempt to create local discontent. The development of commercial affairs along present lines is not at all unnatural, and it is still more logical that the central station should find its natural extension and expansion. We read much about the centralizing of production, yet very little about the multiplication of partners and great distribution of ownership. The leaders of our gas and electrical industries are the active workers who set out to make money by building up a great volume of business and rendering a greater service to a larger number of people. Their successors are not apt to be of their own families, but younger men, who convince the stockholders of their ability as operators and leaders.

The humblest apprentice in the smallest property today has opportunities that were not apparent a few years ago. Let him excel in any feature of his work, and his feet are on the stairs which extend to leadership. His talent cannot go to waste in his own town, for just as soon as he makes good locally, his talent will be in demand in other towns. This gives him an opportunity for experience that does not come to men even after years of experience in one station. He can nationalize himself in his own syndicated organization, for his field is the United States, where business ability will dominate over state lines, creed and race.

There are men in the business by the thousand who have become successful by this process, for the man who is expert upon even a small sub-division of the work of his department, is in demand. Neither are we limited to present conditions. Ten years ago there were not more than a thousand professional "new business men" in our gas and electrical industries, where today there are ten thousand. There is plenty of room today, too, for these ten thousand more men who are adepts in a knowledge of service, to which we have given little or no attention. There is still room in the business for ten thousand more engineers, for never before did we need their talent so much. We have been blundering along, stagnating scores of branches of industries that need scientific direction. Whenever you can show a reasonable assurance that your efforts will extend public service, the syndicated company will create new work and new departments for you. Your specialty may not be warranted in your own town, yet useful and profitable if rendered to a group of towns. Thus, the basis of the syndicated company's universal success.

It may be a needless remark to say that no one with a "holding company" need be embarrassed if accused of connection with a "trust." The term "trust" is a good one, and we should assume the responsibility of all it implies. The public has in the past and will continue giving preference to the "trust" that renders service of the highest type. Likewise, consolidations will continue to be effected, and they will grow and prosper. Corporations will forever be the medium of American progress, and our individual progress will depend upon our personality, initiative and loyalty to the industry in which we are engaged.

Comment on Article in Nov. Issue.

Editor Electrical Engineering:

Permit me to call attention to the fact that, in the article by Mr. W. R. Bowker, page 480, November issue, end of second column, the drop of 3 per cent of total voltage as given in the example will be the drop across any two wires and should not be used as shown. The calculation should be changed as follows:

3 per cent of $2.50 = 7.5$ volts drop. Then the drop line is $7.5 \div 1.73 = 4.33$ and c. m. $= (10.75 \times 200 \times 350) \div 4.33 = 174{,}000$.

This size of wire will give the drop of 3 per cent across any two lines. Further from the remarks made in regard to wire and fuse sizes for a.c. motors, it would be possible to have the wire over-fused, which is not permitted by the insurance companies. R. Thistlewhite (N. Y.)

Southern Electrical Industries and the Panama Canal

(*Contributed Exclusively to Electrical Engineering*).

BY HON. JOHN BARRETT, DIRECTOR GENERAL, PAN AMERICAN UNION.

IN 1880 the United States exported foodstuffs valued at $459,461,673, or 55.77 per cent of the total exports for that year. In 1912, the United States exported foodstuffs valued at $418,737,763, or 19.29 per cent of the total exports for the year, a decline in actual value of $40,723,910, notwithstanding the large increase in value per unit of quantity in recent years. In 1880 the United States exported manufactured products to the value of $121,818,298, or 14.78 per cent of its total exports for the year. In 1912 the country exported manufactured products to the value of $1,020,417,687, or 47.02 per cent of its total exports for the year, showing a gain in actual value of about 800 per cent.

HON. JOHN BARRETT, DIRECTOR GENERAL, PAN AMERICAN UNION.

These statistics are quoted merely to show the change in the character of the export trade of this country. As a food-selling nation, the United States is rapidly losing ground. Domestic consumption is fast overtaking production in all lines of foodstuffs, and in some lines the demand exceeds the domestic supply, and in these we have become a food-purchasing country.

Fortunately our manufacturing industries have grown to such proportions that in many lines we have entered successfully into the markets of the world, and England, Germany and France are beginning to realize what American competition means. We may seem to be "carrying coals to Newcastle" when we attempt to sell high-grade manufactures of steel and iron to these countries, but we are doing it successfully in some instances. But it is not to Europe we must look for the markets to consume our future surplus production. Our best customers are much nearer home.

The total value of manufactures, (including both those ready for consumption and those for further use in manufacturing), exported to Europe has grown from $272,231,364 in 1900 to $432,528,046 in 1912, an increase of 59 per cent; the value of those exported to North American countries (including Canada, the West Indies, Mexico, and the Central American countries), has grown from $100,307,619 in 1900 to $325,679,884 in 1912, an increase of 225 per cent; to South America from $28,129,064 in 1900 to $115,393,527 in 1912, or an increase of 310 per cent.

It is this enormous increase in our exports to other American countries that is the factor in our foreign commerce which should claim the attention of the manufacturers and exporters in every line of production in this country. It is to America—Pan America—that they must look for prospective customers for the surplus production of their enormous industrial enterprises.

This is true of almost every line of manufacture. It is as true of electrical machinery and appliances as it is of cotton goods, agricultural machinery, or railroad equipment. Of the $13,526,802 worth of electrical and scientific instruments and appliances exported in 1912, less than $2,000,000 worth went to Europe; $6,559,380 went to North American countries; and $3,480,818 went to South American countries. Of electrical machinery we exported in 1912, $1,552,215 worth to Europe, and $4,798,532 worth to the countries of North and South America.

If this is the present status of things, how much greater will the relative difference be 20, 30, or 50 years hence? The day the first merchant vessel passes through the Panama Canal will mark the beginning of a new era in American export trade. For the first time in history the industrial interests of the United States will enjoy a tremendous advantage over all competitors for a trade with countries that extend for 8,000 miles along the Pacific coast, from the northern boundary of Mexico to the Strait of Magellan. Last year these countries had a foreign commerce of over $400,000,000, representing an increase of 100 per cent in 10 years. This without having a Panama Canal to put them in close touch with the Gulf and Atlantic ports of the United States, or to facilitate their exchange with Europe. To sell their products to the world, to buy the manufactures they needed, they were compelled to take the round-about course through the Strait of Magellan. Valparaiso, for instance, was 4,141 miles farther in distance and 16 days in time (for a 10-knot freight steamer), from Savannah, than it will be by the canal route. Callao, Peru's greatest port, will be 6,644 miles and 27 days closer to Savannah just as soon as the canal opens.

Accessibility is one of the most important elements which enters into the commercial development of a country. The opening of the Panama Canal will give easy access to the west coast countries of South America. The great saving of time and distance between the ports of these countries and the markets of the world, must result in a large increase in the sale of their products and in the consequent development of their resources. Where they can deliver quickest and sell to the greatest advantage these products, is where they will buy those things which they need and do not themselves produce. The section of the commercial and industrial world which will lie closest in point of time as well as in distance, is the Gulf section of the United States. Next to that the South Atlantic section. The geographical location, therefore, of the Southern States gives them a tremendous advantage over all other parts of the earth in this race for a commerce, the extent of which, within the next 20 years, will astound the world.

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*Mr. Barrett gives credit to Mr. C. E. Albes, of his staff, for assistance in preparing this article, and expresses a desire to interest the South in Pan American Commerce and the Panama Canal.

What has all this to do with the electrical industries of the country? Let us see.

One great factor in the general development of any country is the cheapness and facility with which power may be obtained. The great motive power of the future is unquestionably electricity, and the cheapest source whence it may be obtained is from the force of gravity—in other words, from falling water. Along the 5,000 miles of Pacific coast of South America, coal is very scarce. Even Chile, whose coal deposits have been more fully exploited than those of any other west coast country, consumes annually more than twice the amount her mines produce. But along this coast extends the greatest mountain chain in the world—the Andes. From these snow-capped peaks, tumbling over high precipices, rushing through great gorges, come countless streams racing for an outlet to the sea. Here may be found power sufficient to turn the wheels of all the mills and factories, to speed all the railway trains, to keep busy all the turbines, and to light a world. Electric dynamos will take the place of steam boilers. Even now steam railways are being converted into electric lines in many places. One of the latest reports from Chile is that the government is planning to change the railway from Valparaiso to Santiago, a distance of about 117 miles, into an electric line. Again, almost every little Latin American city of 3,000 population has or is planning to have electric lights and water works. Those which have them installed are extending and improving their plants. Not an issue of the *Bulletin of the Pan American Union* appears in which mention is not made of numerous cities of Latin America where power plants are being erected or plans perfected. This while these countries are in the infancy of their development. How much greater will be the demand for electrical supplies when the expansion of trade resulting from the opening of new and shorter trade routes through the Panama Canal warrants greater expenditures, infuses greater activity, and induces more strenuous efforts throughout these countries?

There will be a continually increasing demand for electrical experts, contractors, engineers, managers, machinery, equipment, and all the countless appliances that go with the varied forms of subjecting this great force to the use of man. Will the Southern States meet the situation and be in position to supply at least a share of this demand? Never before has the South been offered such great advantages in a competition for trade in manufactured products of every kind as her proximity to the rapidly developing and enormous territory which the completion of the canal will open to her. To awaken the industrial interests of this favored section to a realization of the situation, it seems to me to be the special province of such journals as *Electrical Engineering*, and such publications as cover special lines. Let their slogan be, "Get ready for the Panama Canal," and the Pan American Union will always be glad to aid, in any way possible, any propaganda which will tend to draw closer the commercial and industrial relations, as well as social and friendly ties, between this section of the United States and Latin America.

The Public Service Commission—Its Work and Its Aim

A Symposium on Features of Public Utility Regulation.

THERE has probably been no development in connection with the operation and management of public utilities, that has been given more careful thought during the year 1913 than the subject of relations with the public and regulation by public service commissions. The problems involved are now being squarely faced by both commissions and public utility managements and regulation by the former is now or will soon be an established procedure in every state in the Union, to be carried on for a particular and definite benefit to the central station industry and the public.

As to how the public utilities themselves now regard regulation, we quote from an editorial in the *Bulletin* of the National Electric Light Association, the official publication of a now truly national organization of central station interests: "It is to the credit of the National Electric Light Association that it was the first of such bodies, representative of a great industry, to recognize the importance of the new administration era that was thus inaugurated, and that its careful summary of the commission laws of Massachusetts, Wisconsin and New York, made several years ago, is one of the classics of the present portentous literature on the subject, with recent summaries that run into a series of volumes. Managers and operators of large properties have now evidently realized that there is a condition confronting them in a political theory that has been worked out into hard facts; and that if they are to be worthy of their opportunities and responsibilities they must shape their work to the conditions. This is not a doctrine of weak opportunism, but embodies the practical demonstration of the principle and value of private ownership upon whose success not merely our own individual prosperity depends, but that of communities and nations at large.

"The timely and proper tendency is to insist on the high personnel of the commissioners, whether elected or appointed. Here, after all, is the hub of the situation; and the modern commission system must break down, at no distant time of its own weight, if it is not in the hands of competent, clean, high-minded men. Those who are already carrying on these commissions have come to find that financial excesses that meet and deserve public condemnation are already and long since matters of the past, that modern managers of great utilities must necessarily be big, broad-minded men, and that all that is needed to secure for the public the best service at lowest rates, with highest efficiency, is a square deal all around. Names of able commissioners need not be cited here who enjoy the fullest measure of public esteem, and to whose numbers and ranks utilies will be only too glad to see new additions."

These remarks, while probably written by Secretary Martin of the National Electric Light Association, are not necessarily an expression of one man's opinion, as anyone who has attended one or more meetings of central station men during the past year will readily recognize. The remarks are, on the other hand, a concise summation of the general opinion of all open-minded, progressive central station managements. That this is a fact, and to enable a reader to formulate for himself general tendencies, the opinions on same, the problems involved and the aim of commissions in solving these problems, we present in what follows, remarks by those interested in commission work by virtue of being members of same, and expressions by public utility managers. These expressions come from men sufficiently widely scattered to set forth the interesting features of regulation matters throughout the country.

It has been suggested that the United States Department of Commerce through the Bureau of Standards, be authorized to carry on such investigations as will aid in the fixing of standards of service rendered by public utilities and thereby assist the public service commissions of the various states in regulation matters by standing ready to give expert technical assistance when required by the commissions. Congress has now under consideration an appropriation of $100,000 for this purpose and we present here a statement by a member of the Bureau of Standards that fully outlines the use that would be made of such an appropriation and the possible benefits that would result. The movement is an important one, the most important, we believe, of all the suggestions yet made, in as much as it will inject into the regulation by commissions the fair-minded policy for which the bureau of Standards is already known in connection with investigations of any character. It will tend to harmonize the working of commissions and public utilities and give the former the technical and engineering authority that is absolutely essential and that they must command in regulation investigations.

Dr. J. Franklin Meyer, Associate Physicist Bureau of Standards, Outlines Position of the Bureau on Public Utility Regulation.

The supervision and regulation of public utility corporations, other than railroads and common carriers, by state commissions having broad powers, was inaugurated in 1907 when the Public Service Commissions of New York and the Railroad Commission of Wisconsin began a work which has now been taken up by a majority of the states. In 31 of the states and in the District of Columbia, commission regulation of general utilities is now established. In 46 of the states, railroad and common carriers are subject to commission regulation to varying degrees, while but two states have no commissions at this time.

The twenty-fifth annual convention of the National Association of Railway Commissioners was recently held in Washington. A vast amount of most useful work has been accomplished in the twenty-five years since the association was formed. Today, however, "new occasions teach new duties," and in eleven states new commissions or established commissions with vastly extended powers have begun their work during the year 1913. In several states, recently enacted laws are being considered by the people by referendum, and new legislation is pending in a number of states.

It is evident, therefore, that there exists a nation wide problem in the organization of the work of commissions and establishment of standards. Men and methods are new and untried. Few precedents have been established, and the decisions of the courts are confusing in many cases. But the people are demanding results and commissions are keenly alive to their responsibilities.

There are in general, four leading provisions in public utility laws, and commissions are empowered to consider questions of accounting, rates, standards of service and valuation. Questions of accidents and safety, and the issuance of securities are also of great importance. It is now evident that for the consideration of these difficult and fundamental problems, in the thorough and painstaking manner in which they should be considered, adequate engineering and technical data must be had at first hand. Such data can in most cases be obtained only by careful investigation by able and experienced experts in engineering, accounting and valuation.

Inquiries from a number of commissions have come to the Bureau of Standards of the Department of Commerce at Washington, asking for advice and assistance in planning and establishing the strictly technical work of the commission. The theory of the law in most states is to throw the burden of proof upon the utility corporations, requiring them to justify their rates and services. Unless the Commissions can command engineering and technical advice of the highest character, such as utility corporations generally command, they are at once at a disadvantage. To do this individually in each state seems impracticable, and indeed impossible for some time to come. Engineers and accountants for electric light and power, street railway, telephone, gas, water and other utilities, are needed for practically every commission, yet few states have given their commissions sufficient funds for adequate engineering organizations.

In view of these facts, it seems wise for the federal government, through the Bureau of Standards, to cooperate with and assist the state commissions and municipalities, in their technical work. There is no doubt but that the Bureau of Standards could build up the necessary staff of engineers and experts in technical and in accounting lines. There is a wide field for the Bureau in carrying on and publishing investigations of a technical character for the purpose of establishing standards and methods. Uniformity in regulating utilities is becoming more necessary. The mutual cooperation of commissions seems most desirable and advantageous. No better agency for securing this cooperation can be found than the full and free use of the laboratories, equipment and men of the Bureau by commissions to supplement and assist their engineers. Such cooperation now exists to a marked extent between state and city sealers of weights and measures, brought about by the effort of the Bureau, with the hearty endorsement of the states.

For the federal government, through the Bureau of Standards, to cooperate with and assist the state commissions in their technical work, would of course mean no infringement upon the authority of the states. The Bureau does its work without exercising any legal authority whatsoever. Many technical problems could be investigated and the results published and widely distributed, making them available for all interested. Questions of standards of efficiency in operation and management are certain to be of very great importance in the immediate future. The laws of California, Idaho and Pennsylvania provide specifically that utility corporations may, "participate to such an extent as may be permitted by the Commission and deemed by the Commission wise, for the purpose of encouraging economies, efficiencies, or improvements in methods of service, in additional profits which will be afforded by such economies, efficiencies or improvements in methods." (Penn. Public Service Company Laws; Art. III, 1.a).

Commissioners themselves will be likely to hesitate long in deciding that certain operating corporations are to be allowed additional profits and others denied them, without the services of experienced engineers who know thoroughly all phases of the gas, electric light and power, street railway or telephone business, and are capable of judging the performance of any given corporation by the performance of other corporations working under similar conditions.

The maintenance of an engineering staff large enough and experienced for such a purpose can be undertaken by but few state commissions. The federal government can, however, maintain at the Bureau of Standards such an engineering staff, which could make investigations, propose standards of economy and efficiency and advise the various state commissions upon request. Such a staff of experienced and unbiased technical advisers could supplement a commission's own engineers at any time. Cases requiring such advice would be few in one state in one year, but many in the aggregate. The advantages of such engineering assistance to commissions are obvious, yet the commissions responsibility for its decisions would be in no wise lessened.

The Bureau has already investigated certain questions relating to specifications for gas service and methods of testing gas. Several circulars and bulletins have been issued of undoubted value to commissions and gas utilities. Investigations on life and fire hazard in electrical practice and the electrolysis of pipes ,cable sheaths and other underground structures are now in progress, and much valuable information has been obtained and is available.

The whole question of "the Public Service Commission—its Work and its Aim" is just being definitely formulated. If the administrative officers of Commissions are assisted by scientists, engineers and economists, if the problems are studied in a scientific way and the work of regulation done in a judicial spirit, the states and federal government acting in full cooperation in inter and intra-state matters, with the experience of each available to all, the problems of the relation of the public utility to the public it serves, will be in a large degree solved.

Hon. John H. Roemer, Chairman Railroad Commission of Wisconsin, on a Recent Occasion Made the Following Remarks on Regulation of Public Utilities.

The necessity for intelligent regulation of all corporations and individuals rendering public utility services seems to be universally recognized. With the increase of population and the territorial expansion of our cities and villages, the importance of the public services are emphasized. Water, under pressure, gas, electricity, the telephone and the street railway are, at the present day, essential to the health, comfort and prosperity of the inhabitants of a modern municipality of any considerable size. Vast sums of money are invested in plants rendering these various municipal services. As such plants can neither be constructed nor operated except by virtue of a grant from the municipality or state, it is vital to both the owners of such plants and the public that the rights of each and the corresponding duties of the other in respect to the public functions of the public utility be clearly defined, and maintained in a spirit of fairness and justice to both parties. These obligations have generally been prescribed in the franchises granted by the municipalities as state agencies or by the state itself conferring upon the grantees the right to construct, maintain and operate such plants. But as the term of a franchise must of necessity be for a long period in order to induce capital to invest in the the enterprise, experience has demonstrated that it has been impossible to satisfactorily fix terms and conditions of the franchise to meet the unforeseen and unforeseeable exigencies which arise in the progress of time from many causes.

No one can prophecy the changes in the arts embraced in public utility services, the developments and necessities of the communities served or the requirements of the utilities to perform their functions under changed conditions. In the last few years, the enormous increase in cost of material and labor which enter into and become part of the cost of the service which the public utility is obliged to furnish is an element that has not always been counterbalanced by the economics resulting from new investments and increased business, and unless the changes for the service could be increased in such event it would result, in case of the weaker utility, either in an impairment of the quality of the service or in financial embarassment of the corporation or individual rendering the service.

As an illustration of another burden that is often cast upon a utility and which may not be anticipated when the franchise is granted, we may refer to the advancement in the art of telephony which within a very few years has been little less than marvelous. Costly telephone equipments have been scrapped and entire systems reconstructed to meet the public requirement for the best service.

The art of generating electric current has also advanced with such rapid strides that the expensive electric equipment of a few years ago is today found in the scrap pile, having no other value than that of junk. In other utilities the changes have not been so marked and equipment has become more or less standardized, but who can tell what a quarter of a century may bring forth in any art or science? Under the circumstances it is not at all strange that all attempts to rigidly prescribe in detail the obligations of the public utility to the public and vice versa during the life of a franchise have generally met with signal failure. To meet existing conditions, attempts have frequently been made to change the terms of the franchise. This has often resulted in engendering animosity between the public authorities and the management of public service corporations. The negotiations have not always been free from the suspicion that improper methods have been employed to induce those representing the public in the transactions to consent to terms and conditions detrimental to public interest. As a result such public service corporations become a factor in local politics, and questions involving the most important interests of both the public and the corporation have become issues in local political campaigns. Such issues often involve economic laws and sound business principles which cannot be determined by the votes of an uninformed electorate. These unnecessary conflicts between the public and those rendering public services are the cause of more corruption in municipal government than anything else.

Students of economic science have, for many years, been endeavoring to devise a limited franchise which would be adequate during the term thereof to meet the requirements of the public as well as those of the public service corporations, but they have found it impossible to frame a model franchise of any character based upon sound economic principles which could either be limited in time or could prescribe definitely the charges to be exacted or the quality of the service to be rendered during the life of the franchise. Some have advocated the granting of short time franchises, but such franchises of necessity impose an unnecessary burden upon the public. If a franchise is to be limited in time, provision must be made for its amortization. This compels the public not only to pay a fair return upon the investment during the life of the franchise, but also to provide a sinking fund which, with the scrap value of the plant at the termination of the franchise, is equivalent to the original investment. Others have advised the adoption of franchises for long periods of years reserving to the municipal councils the right to fix rates and establish standards of service at definite intervals or from time to time at the will of the councils. The general experience under franchises of this character has not been such as to warrant their commendation. Intelligent action on the subject by a common council has been rare. The expenditure of large sums of money by some of the larger cities to ascertain all the essential facts necessary for intelligent and lawful action on the part of common councils invested with power to establish rates, has been more frequently wasted than profitable, as the facts thus acquired have generally been ignored and action taken which was either prompted by prejudice or based upon ulterior political considerations. Litigation necessarily followed which involved the further outlay of large sums of money on the part of the public and the utility, all of which, in the end, had to be paid by the tax payers and the patrons of the utility.

From an economic standpoint, an unlimited franchise with the provision that the municipality may evoke it at any time upon condition that it acquire the plant by paying to the company the reasonable value thereof is generally regarded by those who have given the subject exhaustive study and consideration as the best kind of franchise. The necessity of the service in all probability will not terminate with or prior to the time of the expiration of the limited franchise. As far as it is possible to peer into the future, public utilities now operating or others of like character will be required to render services to the public after the termination of existing franchises. It must be obvious to all who have given the subject any serious consideration than an indeterminate franchise containing the provision that the rates and service shall at all times be subject to revision by an impartial and independent tribunal, will result in the greatest good to the public as well as to the investors in such enterprises. It will eliminate all friction between the community served and the agency serving it. Naturally such a policy would be opposed by the average municipal politician who rides into office either as a champion or an opponent of the public utility which is usually a factor in municipal politics.

It was with a view of placing public utilities upon a sound economic basis and eliminating all unnecessary friction between the public and such concerns due to causes arising from ignorance of the economic status of public utilities, and their moral and legal relations to the public, that the Wisconsin Public Utilities Law was framed and enacted. That public utilities are virtually monopolies by nature and must be dealt with as such in any just and comprehensive system of state regulation is the fundamental economic principle upon which the law was constructed. Without protection of such monopolies only a limited and inadequate supervision of their affairs by public authorities can be morally justified. This is almost axiomatic. At the very foundation of the Wisconsin system lies a uniform indeterminate franchise, denominated "an indeterminate permit," which gives the corporation a legally protected monopoly. It can never be deprived of its property unless the municipality determines to acquire the same, and then just compensation must be paid therefor, which is fixed and determined by the Commission.

SERVICE.

In the matter of the regulation of service, the work of the Commission has been most effective. Standards of service have been established to which every utility is required to conform strictly. To detect violations of the rules relating to service, the inspectors of the Commission are constantly traveling through the state making secret inspections. These rules differ materially from those in vogue in other states and countries. They place the responsibility for the character or the quality of the service primarily upon the utility, which is required to test its own meters and make various other specific tests of the quality of the service prescribed in the rules and regulations, and also to keep a record of the results of all such tests, which must be kept open for public inspection. While the accuracy of meters is an essential element in the economic use of both gas and electricity, the maintenance of adequate pressures is more essential to the efficient use of either. Consequently, general systematic surveys of gas pressures and electric voltages by means of recording instruments are made. The gas inspectors are in their investigations required to test the quality and purity of gas, take records of pressure in various parts of the systems, supervise the testing of meters and calibrate the testing equipment. The electric inspectors take continuous records of voltage over the distribution systems, calibrate the companies' standard instruments and supervise the testing of consumers' meters and the renewal of incandescent lamps.

RATES.

At the time that administration of the law was first undertaken, it was found that there were few public utilities in the state which did not have in effect a large number of discriminatory rates. While all had established schedules of rates, the departures from such schedules were numerous. By a general order, the Commission compelled every utility in the state to eliminate discrimination of all kinds and charge the regular schedule rates.

As rates made by the Commission are based upon the cost of service, the Commission has, in each instance where a schedule of rates has been challenged, worked out a scientific schedule which classified the services according to the cost thereof. The result of this has been most gratifying. Business has extended and the returns to the public utility increased. As an illustration, one of the largest public service corporations in the state, operating both a gas and electric plant, valued at approximately $1,000,000, was obliged in a rate case, to put into effect a scientific schedule of rates, which provided a reduction of the maximum rates theretofore in effect, but so classified the service that the consumers in each class were paying for the services rendered, rates based upon the cost of the service to the utility. The company estimated that the new schedule of rates would operate to reduce its net revenue approximately $30,000 per annum. Much to the surprise of the management, the business at once began to develop, and as a result of the expansion thereof, within less than two years the management voluntarily applied to the Commission for authority to make a further reduction of rates. This is but one of the many instances of the character that might be called to your attention.

In order to facilitate work along lines of establishing scientific schedules of rates, the Commission has published the rates, rules and regulations of all the utilities in the state, and by comparison and by the use of hypothetical plans, has demonstrated what are reasonable rates, rules and regulations. In a number of cases, small utilities have asked the Commission to revise their entire schedule of rates. In fact, utilities often come to the Commission asking that a schedule of rates be provided which will develop their business. Generally the managements of the utilities carefully study the decisions of the Commission, and are often thereby able to adjust their schedules of rates upon the principles governing the Commission in its actions. Perhaps the larger number of utilities in the state are today operating upon schedules which are more or less scientific and based in a measure upon the cost of the various services rendered. It is gratifying to know that such utilities as have established such schedules of rates have been able to extend their business greatly, increase their operating revenues, and their net incomes, and reduce the cost of the service to the consumers. This is particularly true in the case of gas, electric and water utilities.

In conclusion, I may say of the wisdom of the regulation of local public utilities by means of a state commission, that any one who has given study and consideration to the subject and who has observed the results obtained by the regulation of such concerns by means of a central tribunal must be convinced that such a system of regulation is preferable to a system of regulation by any local municipal authority. Intelligent regulation of public utilities requires engineering, accounting and statistical skill of a high order. Those entrusted with the work of investigation and study of the various subjects presented for consideration must have scientific knowledge in the respective branches or departments of utility management and operation. With a competent staff of experts in the different lines of service, engaged constantly in examining plants throughout the state, it is possible for the regulating board to bring to the solution of every problem arising a breadth of vision and experience that is invaluable both to the public and to the utility. No regulation can be effective which is not based upon accurate information and which is not actuated by a sense of justice and equity. In the light of the past, it must be conceded that an independent tribunal, free from local influences and prejudices, and assisted by a corps of trained experts is better qualified to efficiently regulate public service corporations and individuals engaged in public services than any municipal council or local tribunal. In few instances would it be possible for municipalities to maintain the necessary organization of competent assistants to deal intelligently with the problems involved in the regulation of public utilities. The cost of such an organization would be prohibitive to most municipalities. In central control there is therefore not only efficiency but also economy. One body can serve all municipalities as well as one municipality and serve them better. After six years of administration of the Wisconsin law, the results obtained from its operation have been generally satisfactory. Our experience indicates that a comprehensive system of regulation such as provided by our law is not only advantageous to the general interests of the public but as well to the business interests of utilities.

Hon. G. A. Lee, Former Chairman Public Service Commission of Washington, Remarks as Follows on Public Ownership and Dangers and Effectiveness of Public Service Regulation.

The State of Washington, in favoring and strengthening the Public Service Commission and state regulation, realizes the advantages to flow therefrom, and in rejecting the so-called "home rule" idea, or municipal control, is simply keeping step with such states as New York, Wisconsin and Massachusetts, where home rule has been rejected. This removal of utilities from municipal politics and regulation by state commissions, means better service, better rates, and better conditions generally.

A fundamental important benefit arising from commission laws is the fact that public service regulation is the only reasonable alternative of public control and ownership. Such regulation affords and secures all of the benefits and advantages incident thereto. If such regulatory laws secure to the people good service, reasonable rates, and safe and efficient instrumentalities and facilities, then certainly there can be no logical or convincing argument in behalf of the surrender of such regulations for the experimental and dangerous plan and principle of municipal or state ownership. In my judgment, the passage of public service commission laws in many states in the last few years marks a new regime, and gives to the public that service and those rates to which they are entitled, and gives to the companies that protection and that rate of return which the constitution and fundamental laws of the land permit, and at the same time avoids the dangers and pitfalls of municipal regulation and municipal ownership.

On this phase of the discussion, the fearless and striking position taken by the Hon. B. H. Meyer, formerly Chairman of the Railroad Commission of Wisconsin, and now a member of the Interstate Commerce Commission, in an address at Madison, May 9th, 1910, is interesting and instructive. Chairman Meyer said:

"Every student of municipal life understands the close relation which has generally existed between municipal politics and the utilities located within the municipality. Here were original franchises to be secured, or existing ones to be amended, or expiring ones to be extended, and in the course of the proceedings relating thereto, bargaining was the order of the day. In this lay one of the greatest sources of corruption. Personal connections, influence, money, everything was resorted to in order to achieve the end. If a city council unfavorable to certain desires of the utility was in office today, what was more natural than to make far-sighted plans gradually to bring about a change in the composition of the council in order that the desired program might be executed at the proper time in the future? The general rule was that if the council of today will not do it, then some time in the future a council will be secured that will do it.

"The local politician found in the utilities the most useful vehicle upon which to ride into office. It might be only a street lamp, the extension of a gas or water main, a little tail-twisting about some rate, but small as it might be, it was large enough for a campaign of the self-styled people's champion. The establishment of central commissions takes away from these petty local leaders one of their most efficient weapons and most popular conveyances. The ostensible cry may be the invasion of "home rule," but in reality it is frequently only the wail of the local politician who can no longer rest comfortably on the backs of the utilities in order to accomplish his selfish if not corrupt desires. The central commission has taken the utilities out of politics.

"Even a casual survey of the results of home rule with reference to the business of local utilities generally shows alternate periods of warfare and peace between the utilities and local authorities. This warfare has not always been righteous nor the peace honorable. It has been essentially a conflict of brute forces, frequently conducted by mercenaries ready to barter away with equal facility the rights of the honest investor or the just claims of the public. Scarcely ever have these many years of home rule produced information sufficient for an honest and intelligent man to arrive at a judgment with respect to either rates or service. An occasional court record does provide such information, but that is not always to be credited to the local authorities. Nearly always these contentions deal with the question of rates. The equally important question of service is scarcely ever touched upon. It is the rate, expressed in dollars and cents, which can be used most effectively to demonstrate the efficiency or inefficiency of the local political leader. In one city the bargain with the council might result in very low rates to the municipality and correspondingly high rates to private consumers. In another it might result in high rates to the municipality and correspondingly low rates to the private consumer. But what of that? In either case the soapbox statesman may stand with his thumbs back of his vest and proclaim from the depths of his heart his devotion to the public good expressed in dollars and cents. To the uninformed and undiscriminating part of the public, the pride he takes in low consumers' rates, in low hydrant rentals or low priced street lamps in the one case is as effective as in the other. What is it to him that private consumers pay excessive prices for water as a result of his hydrant rentals? Or what cares he that tax-payers, many of whom may not be water takers, pay excessive hydrant rentals in order that his friends may have cheap water in their homes? Either position makes an excuse for him on election day. Furnishing light to the city whether gas or electricity lends itself to the same kind of treatment and the bribe of a free telephone is not to be despised.

"In other cases, with the knowledge and acquiescence of the local authorities, the grossest discriminations have been practiced upon the patrons of the utility plants. In the same city there may be two competitors engaged in identical industrial enterprises, both using electric power for instance, but the one paying three times as much as the other for exactly the same service. Different private consumers may be paying rates varying hundreds of per cent. Some consumers may pay nothing even for what others pay several dollars per month. An indefinite number of illustrations of this kind could be adduced. In other words, local control of public utilities has resulted in honeycombing the services throughout the country with unjust discriminations in comparison with which the railway discriminations of the past, in the height of their existence, lose some of their notoriety."

I submit that Commissioner Meyer's position is unassailable, and his argument is unanswerable.

DANGERS OF REGULATION.

Coming now to a brief discussion of the dangers of public service regulation, we come to a field that is extremely important. It may be admitted, and in view of the foregoing facts and data, will be admitted that efficient, capable and honorable public service commissioners can and do render invaluable service to the state and to the companies. If, on the other hand, the members of the state commission lack courage and integrity, and attempt to prostitute their position and immense power for ulterior personal or political ambitions, then and in that event the entire superstructure of regulation falls and such regulation becomes a mere fiasco. Politics have no place in public service commissions. The members of these commissions should be men of fine ability and integrity; of fearless and judicial temperament; otherwise the failure of the work will be just as great as municipal control has been in the past, and the fundamental vice of municipal control rests, of course, in the politics of the situation.

Another danger of public service regulation is the fact that many commissions are not able, or are unwilling, to take a broad, fair and reasonable view of the problems confronting them. If, for instance, values of public service properties are placed low in order to satisfy popular clamor; if the law and the facts of the case are ignored; if unfair, unreasonable, and confiscatory rates are imposed and ordered and if, generally speaking, the utilities are not accorded those rights, privileges and protection to which the law and the constitution entitle them, then the dangers and pernicious results of such regulation outweigh all of the advantages and benefits outlined above.

Recently, in Washington, D. C., in conversation with the chairman of a certain public service commission of one of the Mississippi Valley states, he stated to me that in no event should capital invested in public service properties be entitled to a greater net return than 2 per cent. The only argument which he presented in favor of such a statement was that capital, both active and inactive, in the United States, averaged no greater rate. This commissioner either overlooked or ignored the speculations, hazards and dangers incident to many investments in public service properties. He apparently forgot that capital is frequently sunk in these enterprises for many years before any returns are received. He forgot that many of these great industries are constructed years in advance of the time and that large cities are frequently made possible by the foresight, judgment and wisdom of investors in public service properties. In all other industries these facts and factors are rewarded; why not in the public service business? I answered him by saying that the courts, both state and federal, and the most eminent commissions of the United States, had almost universally held that any net return under 6 per cent was unreasonable, confiscatory and unconstitutional. His only reply was that the courts and commissions were wrong. I cite this conversation to show what I mean by one of the very grave dangers of public service regulation.

Other dangerous tendencies might be noted at this time, but space forbids.

In touching upon the last and final thought, as to how regulation can be made more effective, I simply wish to challenge attention to the fact that members of public utility organizations are not only employes of particular companies, but are citizens of the state. As such citizens and as such employes they are charged with the important duty of obeying the statutes and laws of the state.

If they conscientiously perform that duty and discharge the obligations and duties imposed upon them by the public service commission law, there is no question but what regulation can be made more effective. Good service on the part of public service companies can only come from efficiency, loyalty, industry and integrity on the part of its employes. A public service company can be no stronger than the character of the men who constitute it. Such qualities and practices not only spell good service, but in the final analysis mean that fewer complaints are registered against the company, either with the company or with the commission. The people generally require and are entitled to good service; whether or not that service will be furnished rests in your power.

The question of rates is generally a secondary and inferior one, and it is therefore essential that each employe should direct his best energy and ability toward good service. If so, the relationship between the company and the public will be a pleasant one, and the relationship between the company and the public service commission agreeable and harmonious. The attitude of the average employe with whom the public comes in contact frequently determines the judgment and attitude of the public toward the company which the employe represents. This is fundamental and needs only to be stated to emphasize its importance.

The greatest enemy of public service regulation today is the unfair and unscrupulous municipal agitator, desiring political or other preferment and appealing to the sympathies and prejudices of the people. The people cannot always be misled, however, and are rapidly coming to recognize and appreciate that there are two sides to the controversy, and that equity and fair treatment must be accorded the utility if the community is to progress and prosper.

Mr. Richard McCulloch, Vice-President United Railways of St. Louis, St. Louis, Mo., Had the Following to Say in Part on The Present Tendency of Public Service Regulation at Atlantic City Convention of American Electric Railway Association.

The first state to establish control of public utilities was Massachusetts which, in 1885, placed its gas and electric light companies under the jurisdiction of the State Gas Commission. Other public utilities in this state were regulated by different commissions until July 1, 1913, when street and interurban electric railways, as well as gas, electric light and water companies, were placed under the jurisdiction of the new Public Utility Commission. In 1907 the states of New York and Wisconsin placed all of their public utilities under the control of state commissions, and gave these commissions what were then considered the widest and most arbitrary powers. Vermont followed in 1908, and Maryland in 1910. The laws of New York and Wisconsin serving as models, in 1911 public utility commissions were established in New Jersey, New Hampshire, Kansas, Oregon, Ohio, Washington, Nevada, Connecticut and California. Rhode Island followed in 1912.

In 1913 an epidemic of regulation seemed to be prevalent, and during that year public utility commissions were established in Missouri, Indiana, Pennsylvania, Maine, West Virginia, Illinois, Idaho, Montana and Colorado. At present twenty-four states have public utility commissions, and in this number we do not include those states having railroad and warehouse commissions having jurisdiction only over steam railroads, nor do we include the municipal commissions, some of which have been later replaced by state commissions. Neither do we include corporation commissions exercising some of the functions of public utility commissions. Corporation commissions exist in Oklahoma, Arizona, New Mexico, North Carolina and Virginia.

Municipal commissions have been established at various times in Washington, D. C., Wilmington, Los Angeles, St. Louis, Kansas City, St. Joseph and Denver. The Board of Supervising Engineers in Chicago, appointed to carry out the provisions of the Rehabilitation Ordinance, exercised some of the functions of a municipal commission. The Public Service Commission of New York, First District, although deriving its powers from the state, is to all intents and purposes a municipal commission, as its jurisdiction extends only over Greater New York.

In this connection it may be stated that where municipal control through a commission already existed, municipalities have not welcomed the transfer of their powers to state commissions. During the consideration of the Public Utility Act by the legislature of Illinois, a delegation consisting of the mayor and common council of Chicago appeared before the governor to protest against the interference of the state in the municipal affairs of Chicago, asking the exemption of that city from the jurisdiction of the state commission. Similar incidents have occurred where other states assumed powers formerly exercised by municipalities.

A municipal commission, however, is too close to the seat of contention to exercise a fair and impartial judgment. It is too apt to be swayed by unreasonable public clamor, newspaper attacks and personal grievances which interfere with the broad view of the situation necessary for a finding based on the rights of the public, while taking into account also the rights of the utility. A municipal commission, also for the lack of something to do, is apt to interfere unnecessarily in the operating details of the business and attempt to become managers instead of regulators.

TENDENCY OF COMMISSIONS IN FINANCIAL MATTERS.

With few exceptions, the public utility laws provide for control of capital security issues, providing for the sale of stock at par and authorizing the commission to require bonds to be sold at a discount which is established in each case by the commission. This regulation adds to the difficulty of financing a public utility, as the price may be set too high or so much time may have been consumed in the investigation that the favorable moment for the sale of the securities may have passed. Stock without nominal par value, which was strongly recommended by the National Railroad Securities Commission, has not been provided for in any of the public utility laws. New York has a law providing for the issue of stock without nominal or par value, but public utilities are not permitted to take advantage of it, although the law was strongly urged by former Chairman Stevens, of the Second District, and subsequently opposed by the First District Commission.

It is fortunate for the public that the mergers of independent companies into large electric railway systems occurred before commission rule, because under the rulings of present regulating commissions such mergers would become a difficult problem. The large amounts of cash or par value of securities which were expended in purchasing competent street railways, or in payment for going concern values may be much in excess of the value of the physical property, and may not make themselves evident in an appraisal.

In order to effect these mergers, or in order to electrify or rehabilitate the properties, large amounts represented either by cash or by capital securities were issued. The par value of the capital obligations usually exceeds the physical value of the property, and in some cases the funded debt is greater than the physical value. These securities have been issued in good faith and have passed into the hands of third parties. As the state laws and the commission rulings would require in the issue of new securities a substantial reduction in the par value of capital obligations, the satisfactory reorganization of companies so situated is practically impossible except through the tedious, expensive and distressing process of receivership.

VALUATION.

In the consideration of questions involving service, rates and rate of return, the valuation of the property is deemed important, since the theory usually adopted is that the public utility is entitled to earn a fair rate of return, either upon the capital actually invested in the property and in the service of the public or, according to the ruling of some commissions, upon only the present depreciated value of the property. The value may be required for other purposes, such as for tax assessment, for reorganization, for municipal purchase, as a basis for negotiations for extension or franchises, or merely for the purpose of affording something to do for the engineers of the commission.

There are almost as many theories regarding valuation as there are experts in the valuation business, and the number of these is growing daily. The literature on the subject of valuation, most of which has appeared during the last two years, is stupendously appalling. A bibliography recently compiled by the American Society of Civil Engineers consists of exactly 999 books, theses and articles on valuation.

The physical value of the property is usually determined by applying unit prices to an inventory. The accuracy of the inventory and the reliability of the unit prices may vary widely according to the experience, care, ability and honesty of those conducting the appraisal. To the value of the physical property is then added an allowance for overhead charges, such as organization, engineering, superintendence, contingencies, interest and insurance during construction, general expenses, etc. There is no unity of opinion as to the value of these intangible assets, the values allowed ranging from 10 to 51 per cent of the value of the physical property. If the present value of the property is to be determined, the value of the physical property is depreciated, according to its age or condition, in accordance with one of the several theories.

Notwithstanding which theory is followed, the final valuation never represents what has gone into the property. Most of the large city properties have been built up piecemeal, under different supervision, during various stages of the art, under operating conditions, and sometimes under opposition. No theory of contingencies takes all this into account. Anyone connected with large enterprises knows the great differences which often exist between the final cost of work and the original estimate of the engineer. Some commissioners have great difficulty in appreciating that engineers' estimates of reproduction cost are only, at the best, more or less intelligent guesses having relatively large probable errors.

The question of valuation is at present in a more or less chaotic condition, with a strong tendency on the part of each new commission or chief engineer to advance some new theory to solve his particular problem.

RATES OF RETURN.

The wide variation in the rates of return upon the estimated capital invested in public utilities seems to be due to a great extent to the tendency on the part of commissions and public officials to confuse non-confiscatory interest rates as discussed, but not defined, by the United States Supreme Court with reasonable rate of return. In the proper performance of their duties, both to the public and the utilities, regulating commissions should allow rate of return sufficiently high to induce capital to flow into the business which they are attempting to regulate.

Rates of return varying from 6 to 8 per cent have been allowed, and in some instances commissions have declined to reduce rates where the rate of return was as high as 10 per cent.

Reasonable rates of return should vary with the circumstances of each case, with the location of the utility and with the hazard of the business. The rate should be higher for street railway utilities than for other public utilities of similar magnitude.

REGULATION OF SERVICE.

The usual requirement in state laws is that the service shall be "safe and adequate," and that the rates shall be "just and reasonable." No definition is given of these terms, so it is left to the commissioners to determine in each case what is safe, what is adequate, what is just and what is reasonable. What is adequate service is largely a matter of opinion, as no standards for measuring the reasonableness or adequacy of service have been developed.

Public service regulation has come about in most of the states within the last three years. The conditions of operation without regulation and operation under regulation are quite different. The change has been sudden, and it will require time for the utilities to adapt themselves to the new conditions as well as time for the commissions to digest the immense amount of detail, which they must do before they can intelligently pass on the problems presented.

Regulation has been in force too short a time to summarize its results, and determine whether it is worth what it is costing, or is accomplishing what it was intended to accomplish. Public service commissions may have been instrumental in putting an end to certain bad financial practices, but their growing disposition to interfere in the details of the business, and their policy of cutting the rate of return to a barely non-confiscatory basis is not encouraging to investors.

Any community is better served by a prosperous utility than by one which is struggling for existence, and it would appear that a far-seeing regulation would be one which would encourage the investment of private capital. The best interests of the public are surely not conserved when conditions of operation are made so onerous and rates of return are cut so low that capital cannot be procured for betterments and extensions to existing properties, to say nothing of capital for the building of new properties.

Mr. G. L. Myers, Secretary, Pacific Power and Light C..., Has the Following to Say on Personnel of Public Service Commissions, Taken From the Company's Bulletin.

Regulation is no longer a subject of contention between party leaders or political parties, if it really ever was, and it is not, in any sense, a partisan question. It is only a political issue in relation to the so-called "Trust Problem," or in its proposed application to industrial corporations. The Progressive party accepts of monopoly in the field of industry and endorses regulation, the Democratic party positively refuses to do so, contending that competition should do the regulating. In its relation to public service corporations, it is a question concerning which practically all people take common ground. Our changed social and economic conditions made it necessary, together with a growing recognition of the principle that public utilities are natural monopolies possessed of large powers, existent and potential. However, if regulation is to be successful, we must have the right kind of regulation—regulation that is fair to the public and fair to the public service corporations. The public service corporations have come to realize that such commissions are necessary, as much for their protection as for the public's.

Much study and consideration has been given to the provisions of public utility laws in order to insure effective regulation, and too little study and consideration to the personnel of public utility commissions. The kind of regulation that is to be had is entirely dependent upon the efficiency of the commissioners who do the regulating. If there is not an efficient and competent commission, there cannot be efficient and proper regulation. The personnel equation is all-important and of the utmost concern to both the public and the public utility corporations.

A public utility commission is essentially an administrative and quasi-judicial body, in which are vested vast powers of regulation and control, even to the extent of exercising close supervision and direction of the affairs of public service corporations. Control without responsibility is inconsistent. Therefore, it is necessary that men possessed of a sense of responsibility comprise the commission—men who can be fair and just to the corporations, as well as to the public, and impartial and unbiased in their attitude and capable of judging of the merits and facts involved in cases with which they have to deal.

As conditions exist, politics have too much influence in the make-up of commissions. A commissioner is often appointed as a reward for political services rendered the appointive power, or because of his political affiliations. Again, in some cases, geographical considerations enter into the selection of a commissioner. Sometimes he is appointed to strengthen the chief executive in a given locality, or because of other local considerations, or elected by districts, so as to insure district representation on the commission. This is often conducive to the selection of commissioners who are apt to be unfit or to the elimination of men better qualified. The commission is not of local concern, but it is of state-wide concern, and its personnel should not be based upon district representation.

Furthermore, under our present method of choosing commissioners, there is a lack of permanency because of politics. If one party is shorn of power and superseded by another, it generally results in a change of a commissioner or two and, in some cases, a change in the entire personnel of the commission, especially if it is appointive. Thus, a man scarcely becomes familiar with the duties of his office, conversant with the public utility laws and educated in the regulation of public utility corporations before he is deprived of office, not necessarily because he is incompetent and inefficient, but due to his not being affiliated with the party in power.

The Interstate Commerce Commission is a success and has the confidence of the public because it is non-partisan in character, composed of men of ability, capacity, knowledge and experience, and is subject to few changes in its personnel. There have been few changes since its inception and since its membership was enlarged. No public body has more difficult duties to perform and none performs them with a greater sense of responsibility to the public and with more regard for the interests of the common carriers. The national commission itself is a powerful argument for non-partisan state commissions.

We are never going to get the right kind of results through regulation unless we give regulation an opportunity to demonstrate and prove its effectiveness and get it down to a fair, business-like and scientific basis, so that all parties concerned can get intelligent, just and impartial consideration by a commission of experience and learning, having due regard for the rights of the public and a comprehension of the conditions under which a public utility corporation operates.

Mention has been made of a condition. If there is opportunity for improvement or an undesirable condition to be rectified, the question naturally arises as to what is the remedy:

1. The commission should be elected at large by all the qualified voters of the state. This will eliminate appointment by the governor or election by districts.

2. The election should be strictly non-partisan, and no party or other political designation should appear on the ballot after a candidate's name. In a good many of the states judicial officers are selected in a non-partisan manner, and it would seem better if the name of the candidate for commissioner could appear on a separate ballot, along with those of candidates for judicial offices.

3. The election of no more than one or two commissioners biennially.

4. The preferential system of voting should be adopted. This for the reason that it makes possible the selection of a candidate by a majority vote and tends to eliminate the possibility of the election of a candidate who may be unfit, but who has a large personal following. It has a tendency to make the electorate more non-partisan and discriminating in its selection and more probable the selection of a candidate better qualified and more capable. In instances where the preferential system does not meet with approval, the non-partisan elimination primary system should be adopted.

5. The recall should be effective in all cases, more especially where the term is for a period of four or six years. This will be the answer to the opponents of the long term, because it will make possible the retirement of an obnoxious commissioner at any time.

6. The term of a commissioner should be six years. This makes it possible for him to become reasonably familiar with the public utility laws and the problems affecting regulation. In most of the states the commission consists of three members. This would make necessary the election of only one commissioner at an election. In no state is the membership more than twice the number of years of such a term, thus making it necessary to elect, at one time, no more than two commissioners.

7. The payment of an adequate salary, so that the best services can be obtained, and experienced, learned and capable men induced to become candidates. Too often the services demanded and required of a particular officer are totally out of proportion to the salary paid by the state, and prevent the acceptance of office by men who are practical and experienced, and who have been successful and have a proper conception of business methods and administration.

It would be impractical and undesirable to apply civil service rules and regulations because of the nature of the duties performed by a commissioner, but the method of selection should be such that his tenure of office would depend upon merit and service rendered.

In any event, the chief executive should not be vested with the power of appointment. If he is, the appointment will be determined by politics and the commission's personnel, at all times uncertain and changing.

Mr. J. H. Pardee, President The J. G. White Management Corporation, Before the New York Electric Railway Association, on December 9, 1913, Said in Part:

Some of us remember the early days of street railway development when the difficulties and problems which confronted the promoters and operators of traction properties were nearly entirely of a technical nature; the adventurers whose names shall always occupy prominent positions in the history of early railway construction were men of confidence in their own convictions that, in accordance with the fundamental laws of magnetism, mechanics, etc., the forces of nature could be successfully directed to the needs of transportation. The general public stood on the side lines, always interested, to be sure, in the progress, yet assuming no particular risk excepting, perhaps, that which they considered involved in the granting by communities to tramway companies the right to erect poles and overhead wires in public streets for the distribution of the deadly electric current. The public during those years cannot be said to have considered itself as anything in the nature of a partner in the development of traction properties, but rather that the latter were being developed by outsiders who, believing it possible to successfully construct and operate street railways electrically, were willing to risk their fortunes and direct their energies to such development.

Today, as we all know, the situation is very different; the public is indeed considered a partner in the management of the affairs of public service properties. Promoters may be confident that electric railways can be successfully built as far as the purely technical features are concerned; they must now make sure that their schemes have the approval of public opinion. Many have reaped handsome profits in this line of endeavor and some people, not familiar with electric railroading, and giving way to that very natural human instinct which directs one's criticisms at those who have been successful, have endeavored to sketch the successful promoters of public utility projects as highwaymen who bleed the public of its lifeblood by various methods among which they mention, particularly the treatment commonly known as "watering of stock."

In the discussion of present relations of public service corporations and the public, it is needless to include the "pros and cons" of past arguments regarding the proper position of each, the officers of street railway companies are now bearing heavy responsibilities of the new phase of utility administration, this being the guidance of public relationship. Traction lines are public servants existing for the comfort of the people and bearing to them certain well-defined obligations in the way of safe and adequate service at equitable rates; the public owes them fair treatment and protection from the indirect confiscation of their property by legislation making it impossible to earn proper returns on investments in such property. Due to the failure of municipal ownership the public has found, after many costly trials of this inefficient method, that the most expedient and practical solution of the problem lies in the development of traction systems by private capital, together with proper and fair regulation by commissions representing the public interest.

It is certain that, from this comparatively new system of utility regulation, have come a great many abuses of the regulatory power. Prompted by an ill-advised public opinion and, in some cases, ignorant of actual conditions, commissions have been known to impose upon electric railways very onerous conditions, limitations, etc., which have so seriously burdened such companies as to actually set back their development to a very considerable extent by inspiring the ever cautious money leader with fear. Unreasonable regulation can, in the long run, harm no one but the public itself, for it automatically, by the very laws of economics, increases the rate at which money can be drawn into this field of investment, and hence the rates which the public must pay for service. It is the writer's confident belief that, in the abuse of regulatory posers, the pendulum has now commenced to swing back and that public service commissions are coming more and more to realize their obligations to security holders as well as to the sovereign partner, the public.

Having the greatest confidence in the general integrity of our American public, I believe most of the unfair burdens which have been saddled upon street railway companies with the consent of public opinion have been the result of gross misconception concerning the affairs and conditions of operation of such companies. The greater part of the general public know very little about the electric railway business, and are easily misled by those who, being socialistically inclined, picture them as monstrous monopolies, turning over tremendous and unwarranted monetary returns to their owners.

In conlcusion, the writer is pleased to say that he believes, in general, that public opinion has come to realize that it, too, must endeavor to establish a harmonious spirit of co-operation between street railway companies and those whom they serve, in order to arrive at the very best results for all concerned, and also believe we may expect to see a great improvement along these lines in the very near future.

State Water Power Project in Germany.

The Prussian Parliament has recently enacted a law appropriating $2,500,000 for developing water power on the upper reaches of the River Weser in Hanover Province and Waldeck Principality. It is proposed to utilize the water heads afforded by the already existing reservoirs at Hemfurt on the River Eder and Helminghausen on the Diemel, both source streams of the Weser, and later to connect these power plants with a third to be built at Munden, where the conflux of the Rivers Fulda and Werra gives rise to the Weser proper. In keeping with the more recent Prussian policy of direct development of water powers by the State, the waterways department of the Prussian Ministry of Public Works will undertake not only the construction but also the subsequent sale, up to a certain point, of the power to be developed.

The region to be served includes 13 counties in Prussia and 3 in Waldeck, representing a total area of about 2,500 square miles and embracing a population of about 600,000. It is estimated that approximately three-fourths of the prospective demand will be municipal and industrial and one-fourth agricultural. The current will be distributed to 15 points within this region by means of a 40,000-volt transmission system, which will be about 215 miles in total length and will cost to construct about $405,000. At each of the 15 points mentioned there will be a transformer station, where the current will be stepped down from 40,000 to 6,000 volts and delivered to the county governments or companies.

Tall Building Developments in the South and Electrical Considerations

(*Contributed Exclusively to Electrical Engineering*).

BY WILLIAM C. SPIKER, C. E.

Electrical Considerations in the Design of Tall Buildings From Standpoint of a Consulting Civil Engineer.

WITHIN the next five years, from twenty to thirty million dollars will probably be expended in the construction of tall buildings in the cities of the Southern states. Without a definite knowledge of the number of such buildings that have already been constructed within the last four years, the writer can count from memory forty tall buildings in fifteen Southern cities which together have cost from twelve to fifteen million dollars. A large proportion of these buildings are ten stories high and over, which places them in the class commonly known as "sky-scrapers."

It is generally conceded that electricity, together with the elevator, has made this type of construction possible, practicable and economical. The high stories of office buildings in a busy city are now popular on account of the fact that the air is much fresher and cleaner, and there is less noise than in the cases of offices on floors nearer the ground. This, coupled with the ease of reaching a thirty-story office with good daylight and good light at night through electricity, makes the sky-scraper desirable for office use from the standpoint of the tenant. If it were not for electricity, however, some of these features would be wanting and the popularity of the sky-scraper correspondingly reduced.

From the standpoint of the owner, very tall buildings would be commercially unprofitable if it were not for the features above noted, for under present conditions the demand for upper stories often enables the securing of higher rents for same. From the standpoint of the community, tall buildings are not as economical as they often are to the owner. In fact, if the owner of a tall building had to pay to the owners of surrounding property the value of the light which the tall building takes from the other property, there would not be nearly as many tall buildings as there are now. In England, there is a law which practically prevents tall buildings, and the law is based simply upon the fact that when a man builds a tall building on the lot line of a neighbor, he necessarily cuts off his neighbor's light. There is, therefore, a large probability that very tall buildings, from the broad point of view of political and social economies, are not desirable.

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Although electricity has made tall buildings practicable and possible, the writer believes that electricity will eventually make it practicable and possible to discontinue the construction of very tall buildings. If cities were clean and free from smoke, there would not be anything like the advantage of building very tall buildings that there now is, and unquestionably it would be most desirable to build a city having no buildings over ten stories high, thus making it more beautiful than a city with structures ranging from two to fifty stories high. If the agencies at present at work are successful, electricity is going to make it possible to have cities clean and free from smoke, and to make transportation easy and rapid. When this result has finally been accomplished, it will not be economical or desirable from an esthetic point of view to construct buildings over ten stories high.

It will, however, always be desirable to have the offices of a city located in a comparatively small section, and for this reason office buildings should be built in such a location as to take all the advantage possible of light from street areas, and be built with very wide open courts between them. In the writer's opinion, buildings which are not as high as eight to ten stories should not be over two or three stories, except possibly in the case of warehouses and department stores. A building which is not worth a good elevator is not worth an elevator at all and, therefore, should be kept lower than four stories, so as not to need an elevator. If an elevator is put into a building, however, the building might just as well be ten stories high, and so long as cities are as filthy and smoky as they are today, the more ten-story buildings the better.

Regarding the features of electrical installations, such as electric lights and electric conduits in buildings of all classes, the writer believes that designers of buildings, manufacturers of electric equipments and fire underwriters should get closer together and work out a standard construction and methods of installing wires and conduits in buildings, in order to improve on all of the present methods. No doubt, every one interested in building construction is working more or less along these lines, but it seems rather apparent that they are not all working together.

The general practice at present is to build a wire and pipe shaft up through a tall building, and then it seems to make little difference what the construction is, run the wires and pipes from the shaft to the various terminals in the easiest way possible. The building is usually planned without regard to the details of conduit installation, except possibly the single shaft up through the middle of the building and the wiring is roughly marked out. The wiring and piping should, to best meet all conditions, be planned before the scheme of construction of the building is decided upon. In case of a reinforced concrete building where this is not done, the writer has seen the conduits put in in such a manner that the reinforcement was necessarily practically all in the top of the floor slab, while it should be in the bottom, and he has seen enough conduits go through the end of a beam where shear in the beam was necessarily high, to practically double the stress figured for the beams, and be the cause of a possible failure.

As long as pipes and conduits are put into floors and partitions in any place possible after the building has been built or after it is planned, it will be necessary to break up or take up or cut up something to make a place for this equipment. There is often waste space in a building which might be utilized for pipes and conduits if plans for same accompanied the design, while as most designs are made, valuable space is utilized for the purpose. Nearly all floor construction in permanent buildings is made thicker than otherwise necessary merely to allow room for conduits and pipes to go any place and in any direction which may seem to be convenient for contractors after the building is nearly completed. A little extra planning ahead of time and possibly a little extra expense for pipes and conduits would be many times saved in construction and in cutting and changing after a building is nearly or quite completed.

Our Trade With Latin America and How to Prepare For It

(Contributed Exclusively to Electrical Engineering).

BY HON. A. H. BALDWIN, CHIEF OF THE BUREAU OF FOREIGN AND DOMESTIC COMMERCE, WASHINGTON, D. C.

THE Panama Canal, which has now been practically completed by the United States, constitutes perhaps the greatest promotive gift to the commerce of the world ever made by any nation. In fact, it would even appear that other nations are likely to reap the first benefits of this new trade facility more promptly than our own.

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HON. A. H. BALDWIN, CHIEF OF BUREAU OF FOREIGN AND DOMESTIC COMMERCE.

The interest of the commercial public of the United States, however, has been stimulated by the wonderful success of the work of our engineers at Panama, and more attention has been directed towards our export trade with South American countries than ever before. One result is that there has developed a tendency to view the commerce of that continent in a distorted perspective, and many somewhat exaggerated statements have been made by enthusiasts in regard to the great future possibilities of this trade. No one is more interested in this subject than the writer, and it is felt that it is wise to direct attention to certain phases of the matter, a knowledge of which is essential to a reasonable view of the conditions in the countries to the south of us and to a sane appreciation of the probable advantages which will come to us from the completion of the canal.

It is noteworthy that in much of the comment on this subject it is assumed that our commerce with all the South American countries will be materially affected by the canal, and it seems to be forgotten that Argentina, Brazil, Venzuela, Colombia, Uaquay and Paraqua will be reached through the canal only by the small percentage of our exports which may originate on our west coast. It will instead be the trade with Europe, and with the East of the United States which will be of the greatest importance to our west coast areas when the canal is opened, rather than the commerce with South America. It is also well, too, to keep in mind that it is unlikely that there will come any sudden growth in the purchasing power of the residents of Latin America when the canal opens. The countries on the west coast which are really brought into closer commercial touch with us, occupy a very narrow fringe of territory, much of it desert, between lofty mountains and the Pacific ocean, and the entire population of that coast is only about 15 millions, with the buying capacity of the people still relatively small. Of the trade of that area, we already have about 20 per cent. Only two manufacturing countries have more, and we can hope only to increase somewhat our share of this commerce. We cannot expect to monopolize it. Many purchases made by these people will always be supplied from Europe, either because we do not or cannot produce the articles in question, or because the sympathy of the Latin American with European products is too strong to be disturbed by any efforts of our exporters. Still, with this qualifying preface, intended as a warning against making an over estimate of our prospective trade, there remains enough to justify us in urging a close study of Latin America, and an active and intelligent attention to the markets in that part of the world.

It is methods of securing trade information about South America that it seems important in this article, to direct the attention of readers, rather than give specific instances or details which might be valuable to individual firms with a desire to enter the field of that trade. There is already established a vast system for the collection and distribution of useful information in regard to this commerce, but the business man in the United States is slow to familiarize himself with it. He is often needlessly balked in his search for the knowledge that is to be had for the asking, if he knows where to ask for it. Any American firm which may desire to embark on trade with South American countries can establish in a short time a volume of information and ample record which will permit it to handle such trade intelligently. For years our consular officers have been reporting in great detail on conditions in Latin America, and these reports have been published very fully by the Department of Commerce. This department has also sent special agents again and again through all the countries in question and intensive studies of trade conditions, general and specific have been made, and the results embodied in reports which are available to any one. No business man need remain in ignorance of the main facts in this field, for if he so desires he can establish quite a library of books about South America made up of government reports. These reports are full of practical information, and present a complete picture of conditions, commercial, social and political, and afford a basis for sane conclusions by prospective exporters, with respect to the advisability of entering the Latin American field.

For example, there is printed every year in the Daily Consular and Trade Reports, a review of the trade of each of these countries giving all the salient features of its commerce for the preceding twelve months. These annual consular reports constitute the current trade history of each Latin American republic, and a study of them cannot fail to afford either a clear view of possibilities for new trade, or lead to the conclusion that the field is not an attractive one for certain products or activities.

With the information in regard to topography, population, wealth, industries, customs, language, weights and measures, currency, trade conditions, market and transportation methods and similar matters, which it is easy to obtain from readily available consular reports or the bulletins and monographs of the Bureau of Foreign and Domestic Commerce, or the Pan American Union, business men can then carry their studies still further in any direction that may attract them.

Special investigations have been made in South America by the commercial agents of the Bureau of Foreign and Domestic Commerce, into the markets for drugs and chemicals, boots, shoes and leather, cotton textiles, flour, canned goods and proprietary medicines, and reports are now available in regard to these special markets. Further, a careful study of customs tariffs, port charges and the existing methods of imposing import duties has been made by an expert of the same bureau and will soon be printed. A record of the freight rates for commodities from New York and other Eastern cities, to ports and cities on the west coast of South America, is available and similar records for the east coast ports of South America, and from other ports of the United States are planned. A general monograph brought up to most recent date, in regard to South America, will soon go to press and can be added to this trade library of facts about Latin America.

Nor is this all. The consuls in these countries have recently sent in new lists of prospective buyers of American products, and there is now in press a trade directory of South American merchants and buyers, which can be used in establishing new trade connections. The methods of extending credits in the cities of the Southern hemisphere are described in a monograph on "Foreign Credits," and soon a special study of banking will be made to supplement the work already accomplished in this field.

The Department of Commerce prints each month and each year a record of the existing volume of our trade with all foreign countries, and gives this trade in such detail as to articles and products as will permit a business man to learn the amount and trend of the sale of his own product in any foreign land. Few study these figures as they deserve to be studied, as the average man finds a statistical table pretty dull business, and will not take the trouble to dig out the real meat that is usually concealed for him in that type of official document.

When all this flood of facts and figures has been digested by the would-be trader, there will still remain ample scope for the aid of the private commercial agencies in supplementing his efforts. The credit houses give the commercial ratings of firms in South America, as elsewhere; and the commission houses handle the details with respect to shipments, tariffs, packing, preparation of invoices, payment of consular fees and similar matters. The steamship lines are always seeking export freight and passengers, and many commercial organizations have active foreign trade departments which show a commendable activity in assisting the development of this commerce.

Enough has already been said, surely, to convince the reader that he need not grope long in the dark in searching for the details of this subject, if he cares to study it. No real mystery is attached to it. What difficulties exist are those that lie in indifference and a provincial attitude towards countries other than our own. This is linked with a strong reluctance on the part of our young business men to undergo the drudgery involved in learning to speak a foreign tongue, and an unwilling attitude towards a long residence in foreign countries. We cannot expect to make serious inroads into the trade of Germany and England with Latin America until we are willing to go after the business in the same earnest way shown by these nations. Their trained agents, familiar with the customs of the people, able to speak Spanish or Portugese fluently, and willing to make a permanent residence in Latin America, will be found throughout all these countries, and all the facilities of trade, the banks, steamship lines, the credit agencies and similar factors of commerce, are much more closely allied to the trade of our rivals than to our commerce. Until we place our exports on equal terms in these respects, we must be willing to take second rank in our commercial relations with South America. That we will long acquiesce in holding that place is not to be believed. Already there are many indications of a new spirit towards this subject and it is certain that we shall overcome the various obstacles to our commercial development as we fully comprehend them.

It is considered by German interests that local inhabitants are best served if the state itself delivers power to surrounding county governments for distribution than if it is sold to some private distributing concern. Under the proposed arrangement of a new water power system, the existing steam plants will be allowed to remain idle except when owing to low water or heavy demand, they are called upon to assist the waterpower stations. Electricity will be sold to two cities and a railway administration at 0.714 cent per kilowatt-hour and purchased from them when needed at 1.428 cents. According to estimate it will be necessary at the outset to buy only 2 to 3 per cent of the total current consumed in any year not attended by unusual water conditions. It is possible that in the future direct sales will be made to other large establishments, such as manufacturing plants, etc., but for the present, except in the three instances noted, the power will not be sold to ultimate consumers, but to the county governments or to companies formed in one or more counties under special provisions of law.

Electrical Progress & Developments For 1913

(*Written for Electrical Engineering*).

BY D. H. BRAYMER.

A Compilation of Opinions and Reports on Tendencies of Engineering, Manufacture and Installation.

THERE are certain tendencies that seem to be characteristic of every twelve-month period in the development of the electrical industry. The early years form a period of invention and new applications, while later years have formed a period of standardization of apparatus and systems and the extention of successful applications. The tendencies at this time that are of most interest to electrical men are, therefore, tendencies in the manufacture of electrical equipment, progress in its application and the trend of engineering and management in connection with present-day engineering projects.

In the central station field, the past year has witnessed a continuation of electrical construction on a large scale, the building of large new generating stations, and additions to existing ones, to form a part of a large inter-connected system for the generation and transmission of electrical energy over a considerable area. Surprising as it may seem, from the vast amount of capital being used in this work, rates for service continue to decrease, and the quality and reliability of service continue to increase. The consolidation and merging of electrical properties continues to an ever greater extent than in the past, and is probably the important general development in the central station field for the year. The grouping of a number of stations under one management properly equipped with engineering ability and capital and a broad-minded policy has proven a benefit not only to the stockholders, but to the public as well. It has been found that a permanent cheapening of public utility service cannot be secured by competition and duplication. The lesson has been an expensive one, yet the result has in a way offset this feature, for the smaller company has learned that a fair return can be made on an investment, a fair rate given and a good service rendered under economical conditions of operation and management.

High Tension Transmission.

In the field of transmission and distribution of electrical energy, the voltages continue to increase, and as they increase, new problems of design and construction arise. The important problem seems to be the fitting in of the new developments embodying the best of present-day design, with parts of an existing system. Here the increase in size of generators, transformer units, and of generating stations and inter-connected sub-stations with their distributing lines, makes the transmission of electrical energy as interesting as it is complex. For all of the fact that new conditions present new and varying problems, it is most gratifying to know that as yet few obstacles have been met that are impossible of solution and electrical transmission is constantly making possible the application of electrical power, not only in industrial plants and for lighting our towns and cities, but in new fields seemingly closed only a few years back, such as coal mines and the furnishing of motive power for steam railway

Equipment has now been successfully designed and is being constructed for extreme voltages. Already 140,000-volt transmission is being used by the Au Sable Electric Company, in Michigan, and 150,000-volt operation by the Pacific Light & Power Company, in the West. The limit of transmission voltage is not yet, we are advised by F. W. Peek, Jr., of the General Electric consulting engineering staff, in a paper recently presented before the Franklin Institute. He mentioned the fact that transformers have been designed and built up to a million volts, and that a quarter of a million volts may be used for transmission, except at high altitudes, without excessive diameter and spacing of conductors. However, the line conductors must be large for high voltages to prevent the loss due to corona, and besides line insulator design and construction is now a more serious limit than corona, for when a string of insulator units becomes long, the voltages along the string are not balanced, but tend to become higher across the unit nearest the line. After a certain point has been reached, the addition of extra units helps very little. The most serious limit to the insulator is the unreliability and uncertainty of porcelain. It is apparent, however, that some of these troubles can be gradually worked out by a re-design of the parts. At the present time, therefore, it seems that the transmission line voltage limit and many construction problems hinge on considerations of a mechanical nature and on economy, rather than on electrical considerations. Further, Mr. Peek expressed the opinion that the energy naturally concentrated at any point will be exceeded by the demand in the surrounding country before the transmission distances become so great that voltages above the corona or insulator limit are necessary. It seems probable that on this account the whole country could be tied together at about 200,000 volts and the energy that would be an excess at one point transferred to take care of the peak at another, and thus keep the load factor high.

Two of the important problems that seem to be important and serious as time wears on and as experience is accumulated, are protection of lines and transformers and the taking off small amounts of power from high tension lines in an economical and satisfactory manner. It is generally recognized that long transmission lines are not at the present time adequately protected against lightning. Conditions of protection are now so very much better in stations than on lines, that interruptions of service are invariably due to damage to some point of the transmission line. From the success of methods now in use or under development for the protection of transformers and generators, it is certain that with their perfection nothing will cause danger to apparatus except negligence. As a protection for apparatus against lightning at this time, the aluminum electrolytic arrester is considered most efficient and is most used where the appartus to be protected, or the severity of conditions justify the expense of installation. In other cases, the multi-gap arrester seems to fit in, especially in distribution work around 2,300 volts. For high degree of protection, lightning arresters must be

The cost of high voltage lightning arresters makes their installation impracticable for line protection. Overhead ground wires have therefore been depended upon for the protection of transmission lines. While there is no tangible way of estimating the protective value of ground wires except by comparison of line troubles of a large number of systems operating with and without them, the thousands of dollars being spent for ground wire construction each year from data and experience as yet secured, seems to be justifiable. Conditions of operation have, however, been pointed out where their use is questionable. Suffice it to say that the ground wire situation is one on which much technical consideration can yet be given for its definite solution and justification over and above a value and use to shield line wires from direct lightning strokes and the absorption of transients by mutual induction and increased capacity to ground.

Arcs, short circuits and high tension switching are still "bugbears" to the operating engineer since they produce low potential oscillation and impulses of high frequency that travel along a line and have a tendency when reaching apparatus containing inductance and capacity, such as a transformer, to create a destructive voltage. Line insulators have a peculiar habit of occasionally failing due, it has been suggested, to such transient effects, being of high voltage and finding the weakest insulators. As a partial protection against these high frequency oscillations, it has been found best practice to do all switching on the low tension side and equip generating stations with proper bus sectionalizing reactances.

With the success attending the installation of large out-door sub-stations, there has sprung up a demand for a simple form of sub-station structure and design of equipment to enable the taking off of small amounts of power from high tension lines. It is necessary that this equipment be installed and maintained at a cost that is in keeping with the revenue that can be expected from the load that is to be taken off. Already designs of such stations are in use, consisting in the main of 3-phase, pole-type, horn-gap switches protected by fuses and used in connection with out-door types of transformers. The cost of such stations range from $15 to $20 per Kw., exclusive of poles and installation cost, and while this price is within reason for a demand of a good load factor, there are details of construction that makes this an important problem and one on which much development may be expected during the coming year. The metering of the total load for such small sub-stations seems to be an important consideration and one calling for practical arrangement of special instrument transformers. Already one Southern company has the matter under consideration, and a design of transformer containing in its own case the necessary instrument transformers is being constructed to enable metering at the smallest installation and maintenance expense.

Transformers for Transmission Systems.

Transmission engineers now claim that since the current-carrying capacity of transmission lines ranges from 15,000 to 40,000 Kw., the most economical size of high voltage transformers is from 6,000 to 10,000 Kw., arranged in one bank, using single-phase transformers for lines up to about 25,000 Kw. and in two banks in parallel for each line above this capacity. While transformers may be connected either in delta or in Y, it is generally conceded that the isolated delta connection is preferable on account of increased reliability of such a system. It is claimed that under normal operation the voltage stress of apparatus is the same, whether the isolated delta or the grounded Y connection is used, but in case of a ground on one wire, the isolated delta system will naturally be exposed to a higher voltage above ground than would be the case with the grounded Y system. The disadvantage of the grounded Y system, however, is that any ground of the line wires will cause a short circuit, and thus a shut down, which is not the case with the delta system, where operation has been known to continue in such a case for a week with one of the lines grounded.

An important consideration in connection with transformers of large capacity is a design such as to limit the current output of the system which it feeds at times of short circuit. It is also important that the transformer should stand the tremendous mechanical strain which its windings are subjected to on short circuit, and on this account transformers are designed with a considerable higher reactance than formerly, this value being from 2 to 6 per cent in present designs.

It is also found convenient for systems which are sure to expand to provide transformers with taps. It has been found desirable to begin the operation of a system at half the ultimate voltage, and to accomplish this, transformers are provided with 50 per cent taps on the high voltage winding. It is customary also to provide high tension windings with four 2½ per cent taps below the normal operating voltage, so that these taps may be used in compensating for the line drop as the load increases.

In the design of transmission systems, it is being recognized that emergency conditions must be taken care of. It is usual to arrange for such by installing automatic devices so that the disturbing part or piece of apparatus can be cut out as soon as a condition is recognized and the remainder of the system left undisturbed. By properly installing such automatic devices and relying on good operatives, trouble can be sectionalized. It is, however, probable that with the extensive growth of large transmission systems, that more automatic operation of high tension switches will be required and greater reliance placed on them than on operating ability.

The selection of a voltage for distribution where there are a number of small demands to be supplied, seems to be an important one, yet handled differently by different transmission companies. The voltage must be high enough for economical transmission, and yet not so high that the cost of sub-station equipment consisting of transformers, switching and protecting apparatus, is so great as to make it impossible to render a fair return on the capital invested. The development, therefore, of an out-door transformer and its switching and protecting equipment at a moderate cost, and the development of an inexpensive out-door structure, seems to indicate that the most economical voltages for transmission serving small demands is in the neighborhood of 22,000 or 33,000 volts. These voltages are high enough to carry a considerable distance with small loss, and the cost of equipment not be excessive. One manufacturer makes the statement that as many transformers have been installed during the past year of a capacity up to 100 or 150 Kva. and voltages above 16,500, as in all previous years, which is ample indication of the tremendous expansion of power transmission systems.

Among the notable power developments completed during the past year, the one at Keokuk, on the Mississippi River, probably attracted the greatest attention. Over half of the power generated here is stepped up for transmission to St. Louis by means of eight 9,000-kilowatt transformers. Power limiting reactances are also used in this installation, and the use of such reactances for limiting short circuit current has proved a very economical safeguard.

The Big Creek installation of the Pacific Light & Power Company, to operate at 150,000 volts, is also interesting, since it is the first system to be put in operation at such a high voltage. There is little radically different in the construction of apparatus used except that the transformers show the highest development in design and the use of insulation. It is interesting to note that for these high voltage units, there is employed an extension of the already well developed condenser terminal instead of using some untried scheme The developments of the existing line seem to meet the conditions imposed by the higher voltages in an entirely satisfactory manner.

A recent installation of more than usual interest is one by the Southern Power Company, consisting of a portable sub-station for power and lighting. Different from most portable sub-stations, this one contains only transformers with switching and protective equipment. There will be three transformers, each of 1,000 Kva. capacity of the self-cooling type. The high tension voltage will be 100,000, and the transformer designed so that it can be used on voltages of 100,000, 44,000 or 13,200-volts. The low tension coils be arranged for 13,200 and 2,200 volts. This portable sub-station can be sent from place to place and used while repairs or extensions are being made at the various sub-stations.

Self-cooled, oil-insulated transformer design has, during the year, taken another step in the direction of increased size with the introduction of pressed steel radiators, used in cooling the oil. Transformers, with practically the same internal construction as is used in water-cooled units, are thus equipped, and have all the advantages heretofore only known in the small self-cooled units. The largest transformers of this type so far built are rated at 3,000 Kva. per unit, and were supplied to the Southern Power Company for out-door use on 100,000-volt lines. A number of transformers equipped with pressed steel radiators are at present being built for the Isthmian Canal Commission for use on the Panama Canal Power system.

As already mentioned, out-door service has become quite popular and transformer design for same has practically no limitations in regard to size and voltage. Climatic conditions of all sorts have been met with practically no trouble whatever. Several units of 3,000 Kva., 140,000-volt rating, have been installed by the Eastern Michigan Power Company, and a number of other units for 7,500 Kva., 120,000 volts service by the Utah Power Company.

The use of structural steel in out-door transformers of moderate and large size has been in the course of development for several years, but until now the most modern construction contains no cast metal, except small parts, such as lugs or clamps and fittings. Structural shapes, I-beams, angles and channels are used as supports and clamping structures of core and coils, in nearly every case where cast iron in large pieces was at one time used.

Developments in insulation of distributing transformers to obtain safety as well as durability, has been brought about by the Westinghouse Electric & Manufacturing Company, by providing solid barriers of micarta, which afford great mechanical as well as dielectrical strength. Insulating testing transformers and their control have also been further developed by this company and transformers giving 500,000 volts from high tension to ground under normal conditions have been put into successful operation.

With the increasing use of feeder regulating equipment, the auxiliary equipment for the automatic control of induction regulators has been developed to give better regulation through quicker response to voltage fluctuations. In Westinghouse designs this has been accomplished by use of quick-acting magnetic brakes and the use of controlling relays with compounding coils that eliminate chattering and hunting.

A new regulator of General Electric design has been put on the market which is unique on account of its small size and automatic operation. It is of such construction that it may be suspended on poles, the same as distributing transformers. It is used in connection with outlying circuits, on which good voltage regulation is desired, but which are too far from the central station or sub-stations to have the benefit of centrally located regulators. This regulator is motor operated, of the induction type and, although it is in circuit continuously, contains no moving electrical contacts.

Prime Movers—Water Wheels and Steam Turbines.

The use of single runner, vertical shaft turbines for low and medium-head hydroelectric installations, has been an interesting feature of several important water power developments. This type of hydraulic turbine is now being used where either the vertical shaft multi-runner or the horizontal shaft multi-runner has heretofore been used. In former years in order to obtain a reasonably high speed on low head developments, it was necessary to resort to the two-runner units. During the past year or so the development of high speed runners for low-head has made it possible to obtain high speed with only one runner per unit. With high speed runners there is necessarily a very high discharge velocity, and in order to regain the energy contained in this discharge from the turbine runners, it has been necessary that the draft tube diffuse the water very gradually and that sharp bends be avoided. With two runner units, it is in some cases impracticable to avoid abrupt changes in the shape and sectional area of the draft tube, and it therefore follows that with multi-runner units equipped with high speed runners, very high efficiency is impossible. Also with multi-runner turbines, the amount of operating mechanism is more than double, and on this account the danger of a shut down due to this part of the turbine being put out of order is increased.

Single runner turbines of the I. P. Morris design have been installed by the Appalachian Power Company in Virginia, the Augusta-Aiken Railway & Electric Corporation on Stevens Creek, Georgia, the Alabama Power Company, at Lock 12, on the Coosa River in Alabama, and the Mississippi River Power Company, at Keokuk, Iowa. The hydraulic turbines installed at Lock 12 by the Alabama Power Company are the most powerful wheels of this type that have yet been undertaken for installation in this country.

In regard to steam turbine design, the Westinghouse Machine Company reports a new design of units which will enable the production of capacities of 30,000 Kw. and above. Such turbo-units will be known as cross-compound type. The "cross-compound" idea is not an entirely new one, as in the very early days of Parsons turbine design, two separate and distinct turbines were mounted on the same shaft with one large generator. Due to improvements in the design of these units, and the difficulty of proper alignment, this design was suspended several years ago in Westinghouse practice by one larger horizontal turbine coupled to a single generator. The "cross-compound" idea carries the original scheme out further and removes any objectionable features, such as difficulty of proper alignment, etc., inasmuch as it contemplates two separate turbines driving two entirely separate generators, one generator to be coupled to a high pressure, non-condensing turbine operating at the highest speed practicable, and consequently the most efficient speed, and the steam from this turbine exhausting directly into alow pressure cylinder, operating at a lower and more efficient speed for low-pressure steam, and this turbine being direct connected to a second synchronous generator of similar capacity to the first, the leads of both generators being tied permanently together. These generators can be wound for any of the higher voltages considered practical today, such as 11,000 or 13,000 volts. This combination promises to be by far the most efficient unit yet designed, since guarantees made show a Rankine cycle efficiency of approximately 75 per cent.

The Interborough Rapid Transit Company, of New York City, is to install three 30,000 Kw. cross-compound Westinghouse turbines in the early future.

The development of Curtis turbines for the past year, as reported by the General Electric Company, has not been marked by any change of type or any radical departure from previous practice. In general, the tendency has been in the direction of higher rotative speeds and improvements in nozzles and buckets, both in arrangement and material. The earliest Curtis turbine built generally consisted of a small number of stages, each containing several rows of moving and stationary buckets. Consequently, the number of stages was increased and the rotating rows of buckets in each decreased. This tendency has continued.

Several very large General Electric machines have been built during the year and contracted for. A number of large horizontal units from 10,000 Kw. to 20,000 Kw., have been completed and shipped. Other machines of 30,000 Kw. and 35,000 Kw. are at present under construction. These are claimed to be the largest turbine units ever contracted for by any manufacturer and consists of single units, in each case the steam end and generator being directly connected and mounted on a common bed plant. The vertical design of Curtis turbine, which has usually been used for all large sizes, is particularly adapted to speeds around 750 revolutions per minute. The high speed turbine, however, with a large number of stages, is not so well adapted to vertical construction, and machines of this type of the Curtis design are being built with horizontal shaft. The available speeds for large horizontal shaft machines are from 1,200 to 1,800 revolutions per minute.

Generating Units and Large Motors.

The most significant progress made in alternating current generators during the past year has been in the increase in size of units. With motors, however, the progress has been principally one of extended application. In design, development has been marked in turbo-alternators, in the change from vertical to horizontal shaft on large units. In engine type generators the modification of characteristics of those which are driven by gas engines to reduce oscillation caused by these prime movers, is important, while in water-wheel type generators, the perfecting of a scheme of enclosed ventilation in which the direction of flow and quantity of air through the different parts is fixed with respect to the heat generated in these parts, is significant.

In synchronous motors, an improvement of speed torque characteristics to meet the requirements of air compressors, centrifugal pumps, etc., has been accomplished, and in induction motors, the perfection of electrically welded end rings on squirrel cage rotors. Improvements have also been made in coil insulation, both by the production of different special compositions which are designed with particular reference to the different conditions which the coils in service are subjected to (such as those in coal mines, cement mills, floods, dry power stations, etc.), and by perfecting a type of high voltage insulation which prevents corona and thereby the life of coils.

The general tendency toward larger and larger turbo-generating units is evidenced by the sale of such machines as these by the General Electric Co. as follows: One horizontal unit of 35,000 Kva., 1,200 rpm., 60-cycle, 13,200 volts; one horizontal 30,000 Kva., 1,500 rpm., 25-cycle, 13,200 volts, and one vertical 15,000 Kva., 750 rpm., 25-cycle, 13,200 volts to the Philadelphia Electric Company; one horizontal unit, 30,000 Kva., 1,500 rpm., 25-cycle, 11,000 volts, for the New York Edison Company; one horizontal 30,000 Kva. unit, 1,500 rpm., 25-cycle, 9,000 volts, and one horizontal 25,000 Kva., 1,200 rpm., 60-cycle, 12,000 volts, to the Commonwealth Edison Company, Chicago; one horizontal 25,000 Kva. unit, 1,200 rpm., 60-cycle, 11,431 volts, for Cleveland; one vertical unit, 25,000 Kva., 750 rpm., 50-cycle, 11,000 volts, for Southern California Edison Company; two horizontal 25,000 Kva. units, 1,200 rpm., 60-cycle, 4,600 volts, and one vertical, 18,750 Kva. unit, 720 rpm., 60-cycle, 4,600 volts, for Detroit Edison Company, and two horizontal units, 18,750 Kva., 1,500 rpm., 25-cycle, 13,200 volts, for the Consolidated Gas & Electric Company, Baltimore.

The same strides have been made in the size of water-wheel type generating units, as indicated in the production, by the General Electric Company, of fifteen vertical, 9,000 Kva., 57.7 rpm., 25-cycle, 11,000-volt generators, for the Mississippi River Power Company, Keokuk, Iowa, where the station room has been designed to accommodate 15 more of these units; twelve vertical, 10,000 Kva., 55.6 rpm., 63-cycle, 6,600-volt generators, for Cedar Rapids Manufacturing & Power Company, Montreal, Canada; two vertical, 12,500 Kva., 400 rpm., 60-cycle, 11,500-volt generators, for Great Western Power Company; two vertical, 10,000 Kva. generators, 514 rpm., 6,600 volts, for Georgia Railway & Power Company, at Tallulah Falls, Ga, making a total of five units at this station; one horizontal, 17,500 Kva. generator, 375 rpm., 50-cycle, 6,600 volts, for Pacific Light & Power Company; four vertical, 13,333 Kva. generators, 60-cycle, 6,600 volts, for Ebro Irrigation Company, Spain; two horizontal, 12,500 Kva. generators, 200 rpm., 60-cycle, 2,300 volts, for Siskiyou Electric Light & Power Company, Thrall, Cal.

Developments in water-wheel generators of Westinghouse design have been largely in the nature of increased capacities and refinements in manufacturing processes. Notably among the newer machines may be mentioned single vertical type units of capacities in excess of 12,000 Kw., and operating at very low speeds, for coupling directly to single runner water wheels. Units ranging in capacity from 12,000 to 17,500 Kva. have been installed, and are now in operation, showing very satisfactory results. Units of the later size are to be installed by the Alabama Power Company at Lock 12.

Rotary Converters and Motor-Generators.

While large, 60-cycle, commutating-pole rotary converters, and 25-cycle commutating-pole rotary converters have already been developed to a considerable extent, they have this year fully demonstrated the claims of the manufacturer on performance by their successful operation. The results obtained prove them to be thoroughly satisfactory, both from an operating and economical standpoint. The installation of ten 1,500 Kw. and two 1,000 Kw. 60-cycle Westinghouse rotary converters by the Cleveland Railway Company, is worthy of mention, as it is said to be the largest 60-cycle rotary converter installation in the world, and is giving remarkably satisfactory results. As in other classes of apparatus, the tendency is to use larger units. Although no larger 25-cycle units have been developed during this year, the largest rotary converter that has been built to date has been completed by the Westinghouse Electric Company. Nine of these converters, which are of the 2,500 Kw. capacity, have been built for the Aluminum Company of America.

The field of the 60-cycle rotary converter has also been extended through the purchase of the Southern Power Company of three 500 Kw. rotary converter units, consisting of two machines of 250 Kw. capacity each mounted on a single bed plate and arranged for operation in series on 1,500 volts direct current; this station is to extend the present operating province of the Piedmont & Northern Lines. In the matter of high voltage direct current work, the tendency is shown in the purchase by the Southern Power Company of a portable sub-station for their railway work, the car to include a 500 Kw. motor-generator to operate through a suitable transformer, also mounted on the car, from either a 2,400 or 44,000-volt circuit.

The tendency in motor-generator sets has been more and more toward the use of motors having condenser capacity involving new designs. The two 3,750 Kw., 270-volt, 180 rpm., direct current generators used with turbine and reduction gear installed the latter part of last year by the Westinghouse Electric Company for the Cleveland (Ohio) Electric Illuminating Company, are the largest in capacity at 180 rpm. that have yet been built. They are not only demonstrating that they are satisfactory, but they are demonstrating the practicability of the turbine-reduction-gear direct current generator unit.

Large Motor Developments.

The increased demand for synchronous motors during the past year has been very marked. This has been due largely to the development of the synchronous motor for such new services as driving air compressors, centrifugal pumps, pulp grinders in paper mills, machinery in cement mills, fans, etc. This development has consisted chiefly in increasing the "starting" and "pull-in" torque of the motors so that they are capable of running up to synchronism under the initial load of this apparatus.

New fields have been opened also to induction motors. The most remarkable of these has been, perhaps, the application of this type of motor to the propulsion of ships. In this, slow speed induction motors, directly coupled to the propeller shaft are supplied from a variable speed turbine. At full propeller speed, the turbine runs at a much higher, and therefore more economical speed, than is possible with direct turbine drive. An instance of this application which promises great development is the Collier "Jupiter" on the Pacific coast. Other important developments are, a line of motors for oil well service and another for coal-cutting in mines. The peculiar characteristics of the oil well motor are, two speeds with a single stator winding, and the method of supplying the motor with clean, cool air. The coal cutting motor has an enclosed corrugated frame, serving as a complete shield, but still allowing ample surface for cooling, and roller bearings. The largest induction motors of General Electric design sold during the past year are the 3,000 Hp. and 1,800 Hp. motors for Bethlehem Steel Company. Numerous other installations have been made of motors over 1,000 Hp. Almost the entire operating mechanisms of the Panama Canal are operated by induction motors of General Electric design.

The increase in the size and potential of transmission systems has created a new demand for large synchronous condensers to regulate the voltage and power factor on these systems. The extension to manufacturing centers of water power transmission has brought a tremendous increase in induction motor load, and a consequent demand for a large number of comparatively small capacity condensers to supply the wattless load of these motors. As instances of large machines, the General Electric Company has recently furnished a 15,000 Kva., 50-cycle, 6,600-volt condenser to the Pacific Gas & Electric Company, and one rated 4,000 Kva., 60-cycle, 13,200 volts to the Nashville, (Tenn.), Railway & Light Company, for voltage regulation. A new line of smaller condensers in sizes from 100 to 2,500 Kva., is being developed to meet the growing demand for these sizes.

The Bethlehem Steel Company, about the middle of the past year, placed an order with the Westinghouse Company, which is rather unique in character, on account of the fact that at the present time practically all of the reversing blooming mills in the United States are driven by steam engines. The Bethlehem Steel Company's order called for a reversing motor equipment to drive a 35-inch blooming mill. Although there are two reversing blooming mill equipments operating in Canada, the equipment for the Bethlehem Steel Company is said to be the only one in the United States, and will be much larger than the Canadian equipment. It is therefore believed that the results obtained at the Bethlehem works will do much to stimulate the interest of the steel companies in equipments of this kind, for undoubtedly the installation will be a success, from many points of view. It is a radical departure from steam engine practice, for the steel companies have been slow to take up with the motor idea for reversing work, although the Westinghouse Company reports approximately 100,000 Hp. in motor equipments driving non-reversing mills.

For a long time the squirrel-cage induction motor as produced by the various manufacturers, has been considered nearly perfected. The last year, however, has seen a further refinement of this motor in the production of a new steel frame squirrel-cage induction motor by the Westinghouse Company, designed for constant speed, continuous service, in sizes of from 20 to 200 Hp., 110 to 2,200 volts, and a riveted frame type of General Electric design. The first development represents what is claimed to be the most satisfactory induction motor yet produced. Special features of its construction are, that steel is largely used throughout, not only providing great strength, but reducing weight of inactive material to a minimum; rotors practically indestructible, bearings with liberal areas, non-leaking and dustproof; construction simple and number of parts small and interchangeable, and efficiency, power factor and overload capacity unusually high.

A new Westinghouse slip ring motor embodying many advanced features of construction has also been brought out within the year. It is especially designed for operating small cranes and hoists, and for other severe intermittent varying-speed reversing service, and it is built in capacities of 2 and 3 Hp., 3-phase, 220 and 400-volt, 60 cycles, 6 poles. The frame is built of rolled steel. The bearings have liberal areas and are non-leaking and protected from dust. Special attention has been given to ease of dismantling, so that in case of accident repairs can be easily made. The rotor is comparatively long and of small diameter, thus reducing the flywheel effect. This feature, together with the perfect balance and secure attachment of the windings, make these rotors especially adapted for frequent starting, stopping and reversing.

The riveted frame General Electric polyphase motors have been designed to overcome the operating troubles of the induction motors due to insulation break-downs in the stator windings. The motor has high dielectric strength and ability of windings to withstand abrasion due to vibratory or other mechanical causes, as well as deterioration from dirt, moisture, etc. Wire coverings, fiber, wood and various insulating media used, are thoroughly pre-treated with japan and special varnish before the completed stators are subjected to the final dipping and baking processes. "Directive ventilation," a feature whose value was long recognized in European dynamo electric construction before acceptance by experts in motor design in this country, has reached further perfection in the "riveted frame" motors by a still more effective circulation of the cooling air throughout the windings, re-design of the directive fans, air ducts, heads, field core flanges, etc., all having as leading purposes the lowering of operating temperatures, avoidance of so-called "hot-air pockets," adding to the overload capacity of the units and insuring long life to the motor through preservation of the entire insulating structure.

For direct current service, the commutating pole motor continues to maintain its prestige as the type uniting those requisites of electrical stability, good commutation, overload capacity and all-year service reliability demanded under the rigorous specifications of present-day motor practice. One design of commutating pole machine has, during the past year, been simplified, without sacrifice in operating characteristics, by halving the number of commutating poles; that is, one instead of two commutating poles being employed for bipolar machines, and two instead of four commutating poles for machines having four main poles. Using the reduced number of commutating poles, the automatic balancing of the armature and field magnetization at the point of commutation is maintained with essentially the same flux and consequent "steadying" values, for a given motor rating. Logically, if the fixity of the electric neutral is maintained under shifting load conditions as before, very evident advantages will accrue by reducing the number of internal connections, simplifying the general construction of the motor and minimizing the quantity of spare parts needed.

Electric Power Utilization.

There has been a decided increase in the demands for motor driven office machinery, such as adding machines, mailing machines, addressing machines, combined computing and typewriting machines. This has been due not only to the perfection of the motor driven machines, but also to the fact that there is an increasing tendency to analyze the cost of operating offices. The demand for motor driven air pumps has increased to a remarkable degree. Air pumps have been principally used in connection with garages for producing compressed air for blowing up automobile tires. Water pumps are being used in the home, apartment and hotel. There is a particular demand for these in suburban districts, and this is often necessitated by the condition that in several districts throughout the country hard water is plentiful, but there is a small supply of soft water.

A great number of popular amusements, such as moving picture shows, entertainments, lectures, etc., is increasing the frequency in which masses of people are gathered together indoors. This fact, connected with the realization of the benefits of good ventilation, and the injurious effect of poor ventilation has brought about an almost universal use of motor driven ventilating fans and blowers.

The vacuum cleaners of various types continue to be popular. The stationary type has now become a necessity in connection with public buildings, and is considered just as carefully as a heating or ventilating system. Also the very small high speed fan type vacuum cleaners have become more popular in the smaller homes, although the larger homes are often installing stationary types. The heavy portable type is used only to a limited extent in connection with the home, but is largely used in public buildings where an attendant is available to move it from floor to floor during the process of cleaning.

The use of electric welding has been greatly increased through the supplying of the proper equipment by the manufacturers. The welding of metals by the electric arc may be briefly defined as the fusing together of two metals, without pressure, allowing them to melt, mix, unite and then cool. For heavy cutting and for the repair of castings which show defects of blow-holes and imperfect formation, and for general work, the metal to be welded is made one terminal of the direct current circuit, and a carbon electrode the other. Upon placing the carbon electrode in contact with the metal and then simply withdrawing the same, an arc is established between the two. By this means, which produces the hottest flame known, having a temperature between 3,500 and 4,000 degrees C., the metal may be either directly welded, melted away, molded into a different shape or fused to another piece of metal, as desired. With this process the current ranges from 180 to 1,000 amperes, depending upon the class of work being done, 250 to 350 amperes being the average value for ordinary work. For lighter and smaller repair work, the metal to be welded forms one terminal of a direct current machine, while the other terminal is formed by a metal pencil instead of the carbon electrode.

Magnet Switches and Control.

The past year has seen the introduction and successful operation of a line of magnet control switches for industrial service that bids fair to very greatly enhance the application of electric motors to severest industrial requirements. Their design was preceded by long and careful study of the needs of this service and by extensive experimental work. The Westinghouse magnet switch control for steel mills is now in such shape as to control motors driving every machine used therein.

A number of new designs and improvements of existing designs of float switches for direct and alternating current service, automatic controllers and motor starters in crane, fire pump and printing press types have originated with the Cutler-Hammer Manufacturing Company and been described in these columns during the past year.

Lighting Developments.

As reported in the annual lighting number of *Electrical Engineering,* the greatest advances in the lighting field are being made in commercial and industrial lighting. It is gratifying to find a majority of large buildings including office buildings, stores, churches and railway stations now being erected, with provisions for lighting according to specifications of expert illuminating engineers. In industrial work, where the effect of good lighting on efficiency is recognized, adequate lighting is also being installed. The carbon arc is still used to some extent, with the flaming arc and the mercury vapor lamp competing with the tungsten incandescent units.

The important development in connection with the manufacture of incandescent light sources is the introduction of the one-half watt per candle tungsten filament lamp by the General Electric Company. This unit will operate on a current consumption of about 6 amperes and be developed at the start in sizes around 1,500 candlepower. It is predicted that this lamp will be a strong competitor with arc lamps in street lighting. In street lighting the important consistent development is in regard to ornamental systems. Such systems have now progressed to such a point that they are soon to became a standard method of lighting not only in large cities, but towns and cities of moderate size. The arc lamp has successfully entered this field as a competitor of incandescent lamps and seems to be a promising type of installation. The luminous arc lamp is used mounted on an attractive standard. There is some attention given throughout Southern cities to the mounting of decorative arms on standards supporting trolley wires or the installation of a standard which can be used for both purposes.

There seems to be some question of personal opinion in regard to the merits of direct, indirect and semi-direct lighting systems, yet it is an accepted fact that present light sources are too brilliant when placed in the line of direct vision. It is also an accepted fact that the many installations of indirect and semi-indirect systems are improving the general illumination of those structures to which such systems are suited. In the design of fixtures and glassware, artistic considerations are receiving more attention than formerly and without serious loss of efficiency, a large number of attractive designs of glassware are coming into extensive use.

Electrical Vehicle Equipment.

The principal increase in the demand for electric vehicle equipment has been in connection with trucks and delivery wagons. This has been due to the distinct advantages which the electric truck and delivery wagon have over the gasoline truck and delivery wagon and the campaigns so successfully carried on during the year. The increase has been largely due to the better understanding of the details and merits of electric trucks and delivery wagons obtained through analyses of operating conditions and costs.

Paralleling the increased demand for electrically propelled commercial vehicles, has come the increased demand for charging equipment. Such installations have brought about the complete equipment of large charging stations operated by central stations, garages and private merchandizing and distributing enterprises, such as department stores, express companies, etc. Many improvements have been made in the equipment of the charging stations, mainly along the lines of simplifying the method of charging, charging more economically and providing against injury to batteries or operator.

A new universal unit type charging panel has been produced by the Cutler-Hammer Manufacturing Company, made up of self-contained rheostats assembled in frames in much the same way that the convenient sectional filing cabinets or book cases are assembled, each standard panel accommodating any number of sections up to six. These panels are for use on both two-wire and three-wire circuits. Each charging section is a unit in itself, consisting of a slate front 24 inches by 10 inches, carrying the rheostat contacts and sliding brush; a low current circuit-breaker; an instrument switch; a pilot lamp and grid type resistance mounted on the back.

Electric Traction Developments.

During the past year and the latter part of 1912, many noteworthy installations have been made, some of the most important being briefly mentioned here. The most prominent electrification is probably the Norfolk & Western, since this is a recent project now conspicuous among the world's undertakings in the electrification of steam railroads.

Steam railroad electrification for tunnel and suburban service is thoroughly established, and its application for heavy haulage on mountain grades offers equally great advantages. The contract recently awarded by the Norfolk & Western Railway for its 30-mile division from Vivian to Bluefield, W. Va., marks the beginning of a new era in economical railroad operation. Sixty-five thousand tons of coal per day originates on this section, most of which must be hauled up 2 per cent grades and through a 3,100-foot tunnel. The twenty-six 135-ton, 11,000-volt, single-phase locomotives which are being furnished will supersede some of the most powerful Mallett steam locomotives in the world, and they will haul the 3,250-ton trains at 14 miles per hour instead of 7, and thus double the capacity of the division.

The New York, New Haven & Hartford Railroad has nearly completed its extension to New Haven, which affords the most complete example in the world of steam railroad electrification. The electric zone of the New Haven system now not only includes the initial electrified section from Woodlawn to Stamford on the New York Division, but also the Harlem River Division, the New York, Westchester & Boston Railroad and finally the complete New York Division to New Haven—making approximately 550 miles of electrified track. Westinghouse single-phase railway apparatus is used exclusively, covering motor car and locomotive operation, the latter embracing switcher, freight and passenger service requiring over 100 electric locomotives.

The second year's operation of the Pennsylvania Railroad's monster 600-volt electric locomotives and the entire electrification has yielded even higher records than those established during the initial 12 months of electric service. The records of operation now afforded are the criteria, by which future electrifications will be weighed and judgment given.

One of the most modern and extensive electric railway systems on the Pacific coast is that of the Oakland, Antioch & Eastern Railway Company. Single-car, multiple-unit trains and trains hauled by high speed electric locomotives are used to meet the traffic demands. Fourteen modern high speed interurban cars equipped with Westinghouse 600—1,200-volt commutating-pole motors and control assist in serving the new territory being opened up by this system. This system is fully described in the December issue of *Electrical Engineering.*

The Michigan United Traction Company's big interurban system has standardized on Westinghouse control and commutating-pole motors, and is placing in service 46 equipments for high speed operation, and to offer increased accommodations to the public throughout the state of Michigan. The Southern Pacific Company, on its electrified suburban lines in the vicinity of San Francisco, is placing in operation 20 steel cars equipped with four 600 1-200-volt motors and Westinghouse control.

The Pacific Electric Railway, said to be the largest interurban system in the world, with approximately 1,000 miles of track, has installed during the past year 45 new, up-to-date cars, equipped with Westinghouse control and commutating-pole motors, to furnish high-grade, high speed reliable service to its patrons in Southern California. The Dayton & Troy Electric Railway has established through service trains between Dayton and Toledo, Ohio. This service has proven an unqualified success, due to the great continuity of service and close adherence to schedule. The strict competition offered to existing steam service shows further the advance of the electric railway industry into fields formerly held exclusively by steam roads.

The inauguration of locomotive service for the hauling of high speed passenger trains marks the advent of this class of service on interurban electric railways.

The conversion of the steam road of the Lookout Mountain Railway Company, winding to the summit of Lookout Mountain, to electric operation, marks another step in the progress of the art of electrification, not only for the South, but for the country. It is interesting to here note that the largest 1,500-volt D.C. railway system in existence is in the South, operated by the Piedmont Traction Company, of Charlotte, N. C.

The abolishing of steam locomotives and the substitution of electric power for the handling of switching service in and around industrial plants, indicates another step in the advancement of the electric railway industry. Switching service has always been considered the most difficult, due to its inherent requirements. The 60-ton Baldwin-Westinghouse locomotive is equipped with Westinghouse control and slow speed locomotive motors.

These Baldwin-Westinghouse locomotives have placed the entering wedge in a field entirely new for interurban roads, and together with 47-ton freight locomotives, form a very complete locomotive equipment to handle heavy passenger and freight traffic on schedule time. A number of roads have adopted this type during the year.

The New York Central & Hudson River Railroad Company has recently ordered six additional General Electric passanger electric locomotives, for terminal service out of New York City. Early in the year ten electric locomotives of the most powerful type ever built were ordered from this company for the same service. These engines weigh 100 tons each. While the new machines are of the same type and construction, they are somewhat heavier, weighing 110 tons, and due to recent advancement in locomotive design, have materially increased capacity for continuous service.

In point of design and construction the new machines will be of identically the same type as the former ten engines, having an articulated frame with bogie guiding trucks at each end. The cab containing the engineer's compartment and that for the operating mechanism is swung between the two parts of the frame on center pins. Each section is equipped with two-axle trucks having a driving motor mounted on each axle. All the axles are, therefore, driving axles; and the eight motors, of the bipolar gearless type, are of the same general design as the motors on all the previous 57 locomotives, and are provided with ample forced ventilation. The motors are electrically connected permanently in parallel in pairs, and the pairs can be connected in three combinations, *viz.*, series, series-parallel and parallel. They are insulated for 1,200 volts, so that if at any future time it should be desired to operate the locomotive on this voltage, the pairs of motors could be changed from parallel to series connections, and the same speeds and control combinations obtained as on 600 volts. A description of the ten locomotives mentioned as already furnished the New York Central & Hudson River Railroad Company, was published in the June, 1913, issue of *Electrical Engineering.*

The number of railway companies operating partly or entirely on power purchased from central stations, is greatly increasing each year. The 60-cycle rotary converter, through its economical and reliable operation, makes possible such arrangements with mutual advantage to both the railway company and the power company. The following lighting companies have recently contracted for railway loads: Cleveland Electric Illuminating Company supplies 17,000 kilowatts to the Cleveland Railway Company. Philadelphia Electric Company supplies 850 kilowatts to the Philadelphia Rapid Transit Company. They also supply a much larger block of power through 25-cycle converters. Connecticut River Transmission Company supplies 6,700 kilowatts to the Worcester Consolidated Street Railway Company.

Telephone Systems and Apparatus.

While a large number of new and detail improvements have been made during the year in connection with telephone equipment for general communication, the decided tendency is to perfect already existing apparatus which has proven its efficiency through satisfactory service. The following remarks cover developments in the telephone business and apparatus o fthe Bell system as manufactured by the Western Electric Company.

Probably the most important addition to telephone development during 1913 is the work being carried on in mining districts to bring about safety for the workers in the mines through the use of mine rescue telephone equipment. Rescue crews, although equipped with oxygen helmets and various safety appliances, have heretofore been considerably hampered in their work by the lack of means of communication with the outside of the mine.

The mine rescue telephone equipment consists of a transmitter which is arranged to fit the throat of the helmet man, thus permitting of the transmission of the sound waves through the walls of the throat, as the mouth is needed for the breathing in of the oxygen. A head receiver is also furnished, the combination of receiver and transmitter being held in place by a light but serviceable leather harness. The helmet man also carries one or more coils of wire, which connect to the telephone equipment used by the directing party at the mouth of the mine.

Railway train despatching by telephone is now established, the development being in standardization of equipment. A new test board for way station service has been developed to meet the need for a compact and flexible testing and patching equipment. These test boards are so designed that all line terminals are made accessible for inspection by merely unhinging the outside cover, and all jack and key terminals by unhinging the apparatus board. The use of these new test boards provides a simple means for minimizing service interruptions. A series of cordless jack boxes has also been developed for block telephone and telegraph service.

The hand set now completes the line of inter-communicating telephones of Western Electric design. This type of instrument has transmitter, receiver, and ringing button, all mounted on one handle. This hand set is interchangeable with the wall and desk types now standardized for any system in types for office, home or factory.

Telephone switchboard development work has been confined to changes calculated to improve the old as well as the more recent types. The work has centered upon the standardization of switchboard frameworks and parts, and applies principally to the magneto non-multiple switchboards.

The use of insulated transmitters is being extended as rapidly as possible to all types of telephones. Heretofore the metal frame of the transmitters has been used as one of the conductors, while the cord attached to a small binding post in the interior of the transmitter has served as the other. The insulated type is inherently a safer instrument to use, as the danger of shock is eliminated. Following the introduction of the one-piece lug holder, which added so much to the graceful appearance of the desk stand, a still further improvement has been effected by the development of a single-piece switch hook.

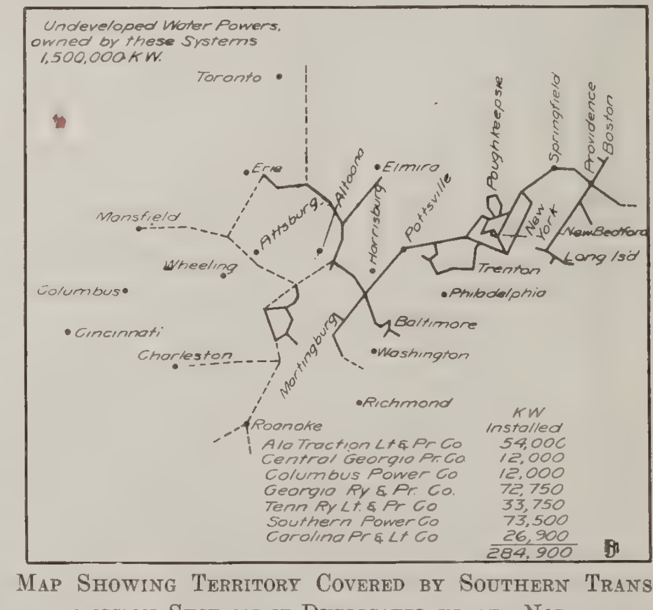
Tendencies in Southern Engineering and Southern Industries.

It has been our custom in past reviews to attempt a summary of progress in electrical engineering and construction in the South. We are particularly fortunate at this time to be able to present the remarks of an engineer who is in an excellent position to note the characteristics of important developments, and tendencies. In what follows Mr. T. Julian McGill, manager of Atlanta office of the Westinghouse Electric & Manufacturing Company, outlines important developments in Southern electrical progress:

"The most marked advancement of Southern hydroelectric companies has been the tying together of all the hydroelectric stations in this section under a give-and-take power contract. This is of material moment to the public, since by taking advantage of the flow from different water sheds, a most reliable service can be rendered in almost any section of the South. Few people realize the tremendous area covered by our Southern transmission systems and to roughly give an idea of this extent, the accompanying map has been made up showing the territory that would be covered should an exact duplicate of our Southern systems be installed in the North.

"During the past year, lightning has been the one serious cause for interruptions of these various transmission systems. This trouble is being now carefully studied by manufacturing companies and marked improvement in lightning protection being offered by them, which, together with a better general understanding of the subject by the operators of hydroelectric systems will decidedly improve conditions in the future. Last summer, from the standpoint of lightning, was the most disastrous one we have yet experienced, and so far a study of the experiences of all transmission companies has not shown any fundamental basis for the elimination of this difficulty. Each stroke of lightning causing an interruption, seemed to have a distinctive characteristic of its own. However, this question is being thoroughly considered at this time by the very best experts in the field and with the facts being secured and analyzed, we hope to soon make an advance that will better the conditions.

"Important development work is now going on in the South. The Alabama Power Company is installing on the Coosa River in Alabama at Lock 12, four 13,500 Kw. generators. These are of vertical design, to operate at 100 rpm. and weigh about 500,000 pounds, with a fly wheel effect of 12,000 foot-pounds. Provision is made for six of these units, making the power house the largest in the South, and having installed in it the largest individual units. In connection with this plant there has also been sold 4,500 Kw., 100,000-volt transformers, with an aggregate capacity greater than 100,000 Kw. Several other hydroelectric developments have been started during the year, a notable one being the Stevens Creek development of the Augusta-Aiken Railway & Electric Corporation. Among those developments to start operation during the year, is the station of the Tennessee Power Company at Parksville, The Hale's Bar development of the Chattanooga and Tennessee River Power Company, the Tallulah Falls station of the Georgia Railway & Power Company and station of the Columbia Power Company on the Chattahoochee River. Many of these large properties are certain



	KW Installed
Ala Traction Lt & Pr Co	54,000
Central Georgia Pr. Co	12,000
Columbus Power Co	12,000
Georgia Ry & Pr. Co.	72,750
Tenn Ry Lt. & Pr Co	33,750
Southern Power Co	73,500
Carolina Pr & Lt Co	26,900
	284,900

MAP SHOWING TERRITORY COVERED BY SOUTHERN TRANSMISSION SYSTEMS IF DUPLICATED IN THE NORTH.

to build up important industries in the South. A striking example of this is the Ocoee property of the Tennessee Power Company, which was successful in bringing into Tennessee a very large installation to be made by the Aluminum Company of America.

"The Southern Power Company's steam auxiliary stations are now in operation and of material value to the system, not only in furnishing power during low water but also in the use of turbo-generators for line characteristic correction. These machines are located at the various power centers and at the end of long transmission lines. The generators are of 8,000 Kw. each, so that they have a large capacity for corrective effect.

"In the railway field of the South, other than the type K Westinghouse control has been taken up for the first time during the past year. The Westinghouse HL control will be used on the Stone Mountain line of the Georgia Railway & Power Company from Atlanta, and on the Lookout Mountain line at Chattanooga, and for city service in Birmingham, Ala. Among the many advantages of the HL control is the removing from the platform of the K type controller.

"Some of the notable industrial installations in our territory are beginning active operation, the largest and probably the most important being the American Steel & Wire Company in Birmingham, Ala. In the Southern cotton mills, there has for some years been a tendency toward use of individual drives. This tendency has during the past year been stronger than ever and some installations have been made in accordance with the very highest refinements in the art. The results secured will undoubtedly show conclusively the value of this type of drive and will warrant the installation and cause such apparatus to be installed by many mills that are not electrified at the present time, as well as some of the mills that are now electrified but using group drives. Considering all things, it is safe to say that no section of the country enjoys a greater progress along electrical lines than the South does at this time."

English and Continental Electrical Developments for 1913

(Contributed Exclusively to Electrical Engineering).

BY R. E. NEALE, B. SC. LONDON, A. C. G. I.

GENERALLY speaking, 1913 has been a good year in the British electrical industry, and there is every reason to hope that this prosperity will continue during 1914. Labor unrest still prevails, but only in Dublin has serious trouble arisen during the past year. Affairs there are still too crucial to permit any estimate of the probable conclusion and effects of the struggle. Speculation has been rife concerning the probable effect of the American tariff on British trade. In some directions beneficial effects are expected, but no one appears to be excited about the matter. For one thing, there is no guarantee that the reductions will endure for more than a few years.

The only international exhibition of importance in 1913 was that at Ghent. The writer can testify as to the excellent municipal organization and lavish expenditure on this event. The result was undoubtedly fine, but international exhibitions are becoming too frequent. From the electrical standpoint, Ghent was disappointed; France alone was adequately represented in this field.

The money-making possibilities of specialization in the design and manufacture of "small" goods is gaining ever wider appreciation. In this connection, the decision of Messrs Ferranti to abandon heavy switchboard contracts and concentrate on "catalog material" is significant. In Germany, the "understandings" existing between, or the actual amalgamations entered into by practically all the electrical manufacturers of importance, are causing some concern, particularly as the manufacturing companies are endeavoring to assume ownership or control of central stations all over the country—thus securing large and permanent consumers for plant equipment and materials. An association has been formed to combat this tendency and to secure public interests in cheap and unfettered electricity supply. The German tax on lighting materials (an iniquity which one would have thought could not be committed in these days), has practically killed German export trade in this line to Canada and the States.

CENTRAL STATION TENDENCIES.

The power of turbo-generator units is now beyond adequate conception; probably the 50,000 kilowatt unit, when it arrives—and it is quite likely to soon—will cause no more excitement than the 5,000 kilowatt unit of ten, or the 500 kilowatt unit of twenty years ago. Dr. Ferranti has applied his investigations on "steam-gas" turbines to the construction of a 5,000 Hp. unit which, it is said, consumes no more than 7 pounds of steam per horsepower-hour on two-third load. The inventor deprecates the construction of large oil engines. The turbine, says he, is the machine for large outputs, and the power station of the future will comprise a large by-product recovery gas plant supplying gas to boilers and oil for internal combustion engines. The Ljungstrom steam turbine is gradually attaining that prominence to which it is undoubtedly entitled. The reduction in the size of steam turbines for large outputs is no less remarkable than the fact that it has attracted but little public attention.

All over France there is a remarkable tendency towards concentration of electric power generation either actually by the erection of very large stations or in effect by the amalgamation of existing large stations. The northwestern district is at present the least exploited power field. The development of lignite (brown coal) stations is making much headway in Germany. A number of "overland" stations have been built near the lignite deposits, some of which are of enormous extent. Italian power developments include important hydro-electric projects in Calabria and Scandinia, whereby 150,000 Hp. and 15,000 Hp. will ultimately be rendered available, while wide areas of country will be protected from drought, flood and malaria.

Frequent additions are required to the generating plant of most central stations in this country to meet the rapid increase in electric demand for all purposes. For large stations, turbo-plant is standard practice, but gas and Diesel equipment finds considerable favor in small and medium-sized concerns. At West Hartlepool, the municipal central station has concluded a 30-year agreement with a local iron-works for the supply by the latter of exhaust steam to mixed pressure turbines provided by the corporation, in exchange for electrical energy. The corporation will save greatly in operating, coal and water costs. The 1,100 Bhp. hydro-electric station at Chester (England), utilizing both tidal and head waters, is unique. Three vertical shaft Francis turbines are installed to work under a head varying from 1 to 9 feet. A serious attempt to utilize tidal power for the production of electrical energy is being made at Husum (Schleswig-Holstein). The present proposals provide for a 5,000 Hp. plant costing, together with the necessary dams and sluices, (which will at any rate reclaim 4,000 acres from the sea), some $1,000,000.

There have been an unusual number of central station fires at home and abroad. Generally, these originate on the switchboard and are traceable to the fact that switchgear and board design and construction have hardly kept pace with the increase in size of generating units and total station output. Owing to the extreme concentration in modern stations, the direct and indirect damage caused by such fires is immense. Large storage batteries are gaining in favor as safeguards against shut-down as well as cheap alternatives to peak load machinery.

DISTRIBUTION AND WIRING.

No specially remarkable development has to be recorded from England. Our power companies continue to extend their load and networks freely but circumstances do not permit any sensational methods or equipment. In the house-wiring field, there has been a marked slump in special wiring systems. The conduit system using crude barrel or slip-in joints with continuity pins represent standard good practice.

A 60,000-volt, single-phase underground cable—believed to be the first of its kind—has been installed in the network supplying the Dessau Bitterfeld railway. The 100 sq. mm. stranded aluminium core is covered by a 30 mm. layer of impregnated paper. The lead sheath is covered by jute coated with asphalt and chalk. Carrying 240 amps., the full load output of the cable is 14,400 Kva., the ohmic and inductance drops are 150 volts and 35 volts per km. (0.6 miles.)

It is proposed to transmit 11,600 Kw. at 100,000 volts from Trollhatten to Copenhagen, a distance of 240 miles, not the least interesting feature of the scheme being the proposal to lay a 3½-mile, 20,000-volt submarine power cable between Helsinborg and Helsingor across the Strait of Oresund. The use of a 100,000-volt submarine cable was seriously considered. Using the Thury system, it is estimated that the annual cost per Kw. would be $6.75 as against $12.43 on the 3-phase system.

INDUSTRIAL POWER.

As foreseen at the time, the great national coal strike caused an enormous increase in industrial electric power connections all over the country. Most of the firms who accepted "temporary" supply in the hour of trouble have kept to it ever since and other firms have applied bitter experience to the same end. The design of direct current electric motors is now highly standardized and waterproof and submergible types prove extremely useful in many applications. Many new types of alternating current motors continue to appear. Considerable improvements have been effected in variable speed three-phase motors and the permanent and increasing importance of this class of machine is assured. Important progress has been realized in codifying international nomenclature, ratings and specifications for electrical machinery and apparatus. The difficulty anticipated in the way of allowing for different climates and altitudes appear by no means insuperable.

Another year's experience goes to prove that electrical apparatus when properly installed and operated in mines is in no way responsible for the frightful disasters which still occur. There are growing up conditions in machine mining and in the applications of electricity to mining which will call for the employment of mechanical and electrical engineers as well as of mining engineers in collieries. The use of electric safety lamps continues to extend and many improved patterns have been placed on the market. In this country self-contained lamps are alone permitted. The use of a flexible lead, however, well protected, between the lamp and a separate battery case does not appear desirable.

RURAL LOADS.

The use of electric power on farms has yet to be developed in this country. It undoubtedly represents a very rich field of enterprise. Excellent results are reported from Germany and about 15 per cent of the total 23,000 Hp. of mechanical power used on Swiss farms is provided electrically. The rate problem is of considerable importance in this country and has been successfully solved by electrical means in a number of tiny hamlets. In most of the thousands of villages to be exploited there is no other competitor than oil lamps. The personal element enters very largely into the success or failure of electric schemes in such cases. The best course appears to be for a private person or company to operate a number of village stations dealing also in the supply and installation of lamps and other apparatus.

ELECTRIC TRACTION.

A great advance in the field of direct current traction has been achieved by the adoption of 3,500-volt line pressure on the Lancashire & Yorkshire railway. Each 62-ton motor coach is equipped with four 300 Hp., 1750-volt, D. C. motors driving the axles through single gears. Weight is here saved as compared with single-phase systems but it is unlikely that this advantage could be restrained in main line locomotives of 2,000 or 3,000 horsepower.

Within a few years all the suburban railways of London will probably be electrified and profusely interconnected. The change in transit facilities during the past decade is increditable. The number of journeys per head of population has increased 51 per cent during the past seven years and now numbers 230. Trams and buses account for two-thirds of the total of nearly 2,000 million journeys effected per annum. The number of licensed power road vehicles (public) is now about five times as great as the number of horse vehicles. The increase in street accidents has become a grave problem. The London, Brighton & S. C. railway continues to experience the benefits of their electrification; the further work now proceeding shows their satisfaction with the single-phase system and constitutes one of the largest electric traction projects in this country. Work is proceeding apace on the London & Southwestern railway suburban electrification scheme and it is hoped that a considerable length of converted track will be opened before the end of 1914. The East London Ry. electrification scheme is in hand.

Suburban and main line electrification on the Continent continues to make good headway, a number of important schemes having been inaugurated during the past year. Several frightful accidents here and on the Continent have again called attention to the danger of gas lighting on trains. A number of excellent electrical systems are available and it is more than probable that legislation will soon compel their use. Renewed attention has simultaneously been attracted to automatic cab-signalling systems.

Electric road vehicles, particularly commercial lorries, appear at last to be obtaining a grip on the English market but there is no denying that a number of electric vehicles offered are still ugly in design. On automobiles of all kinds, the use of electric car lighting systems is now regarded as standard practice and numerous satisfactory types of electric self-starters find frequent application.

In the field of electric ship propulsion, the electrically driven cargo ship *Tynemount* marks a great advance. This 2,400 ton vessel measuring 250 ft. x 425 ft. x 19 ft. is equipped with two 6-cylinder, 300 Hp. Diesel engines driving three-phase alternators which supply a 500 Hp. induction motor. A novel system of double frequency (20 and 26.6 cycle) control is employed. The use of electric motors in place of donkey engines for the driving of deck gear on ships is admitted to offer the advantages of flexible control and cheap operation but the capital cost of suitable motors and switchgear appears still to be rather high.

LAMPS AND LIGHTING.

It is now generally believed that semi-direct lighting for interiors is usually preferable, economically and from the illuminating standpoint, to purely indirect lighting. Many of the more elaborate fittings are however still very inefficient, but this must not be taken to mean that many excellent types are not available. The struggle between gas and electric lighting is still fierce but there is no doubt that the arc and metal lamps are winning. Readers have doubtless heard of the Manchester street tests and the improved forms of dioptric globes to which they led. It is unnecessary to do more than mention the half-watt metal lamp; its effect will be great. Silica mercury lamps are doing well and new applications for the Moore lamp have been found in tube railway escalator tunnels and on moving picture hall and other facades. The Neon lamp gives an orange-red light and can easily be arranged in the form of letters etc. for advertising purposes; many examples of such are to be found in Paris.

Further reductions have been effected in the cost of metal lamps, retail prices now ruling tungsten types being 52 cents for 10 to 60 watts, 100 to 135 volts; 64 cents for 30 to 60 watts, 200 to 260 volts, and $1.02 for 100 watts, 100 to 260 volts lamps. One effect of the present patent and combine position is that there are a number of excellent metal lamps on the Continent which may now be used in this country.

COOKING AND HEATING.

Progress in this field has been marked by great improvements in the design of apparatus—particularly as regards heating elements and the mechanical construction and cheapening of the whole. Many new and excellent types of domestic heaters have been placed on the market and arrangements are made in some districts to hire out cooking apparatus. The policy of the "Point Fives"—central station engineers who supply current at 0.5d. (1c) per kw. hr. for heating and cooking—is bearing fruit. There are now nearly twenty members of this association. A number of electric restaurants have been established in various cities and are proving highly successful. The use of electrically driven ice-making machines is increasing in this country but our climate is not such as to encourage wholesale developments in this direction.

TELEGRAPHY AND TELEPHONY.

The confusion and dissatisfaction following the assumption by the post office of the National Telephone Co.'s activities was real if somewhat exaggerated. Matters are now more satisfactory, but very heavy outlay is required on new apparatus and exchanges. Automatic exchanges and in other cases subscribers' call-meters are lines of development. Long distance telephony has been much improved and reduced "zone" message rates have been introduced between England and France. Satisfactory telephonic communication has recently been established between Vienna and Sarajevo, a distance of 875 miles. Some of the overhead lines involved are of very small diameter. The Krarup distributed loading system is employed owing to the many changes from submarine to overhead construction.

In the wireless field, Marconi interests are certainly predominant not to say monopolistic in Europe but it is something of a mystery why one, at least, other great company does not make better progress. Open tenders have been invited for the second batch of three British Imperial wireless stations and a commission has been appointed to consider how the State may best encourage wireless research. There is no probability of existing submarine cable interests being seriously affected by wireless telegraphy for years to come but the extension of submarine cables has undoubtedly received a check. It is expected soon to effect direct wireless communication between Brussels and the Congo States, wherein a very complete network of stations has been established. The Hovland automatic coding, decoding and printing system of wireless telegraphy is interesting and important and Signor Moretti expects much from his system of multiplex radio-telegraphy using tuned "monophones."

The time signal and weather report service given by the Eiffel Tower and Norddeich wireless stations is widely appreciated. Small receiving sets for use in land stations or on board fishing smacks etc. have been marketed in abundance and at several points on the northwest coast of Europe. "radiophares" have been established to enable mariners to take their bearings with certainty in storm or fog. The proposal to charge $5.00 per annum for wireless licenses has aroused most strenuous opposition in this country.

An Electric Tractor.

The design of an electrically operated tractor for handling lumber at a saw mill has been announced by Woodward, Wight & Company, Ltd., of New Orleans. This machine is the result of a year's experiments at the plant o fthe Industrial Lumber Company at Elizabeth, La., where two of the tractors are now in successful operation.

These machines consist largely of parts of standard electric trucks, combined with special patented features, which make them suitable for use with any standard lumber buggy. It is claimed that the tractor will do the work of from six to ten mules. Rubber tires protect the tramway, and the cost of upkeep, when compared with mules, is negligible. Storage batteries operate the tractor and it is so simple that any man of ordinary intelligence can operate it.

New Business Methods and Results

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

A Review of the Year's Work.

The work of this department of *Electrical Engineering*, has been carried on during the greater part of two years and during this time we have taken up and discussed a number of new business topics. It seems appropriate at this time, therefore, to briefly review the nature of these discussions and announce the plans of this department for the coming year. During 1912, we directed attention principally to the general policies of central station management, such as public relations, co-operation with other industries and matters of internal organization. These subjects were taken up in a general way and are by no means exhausted. The treatment formed a part of a carefully laid out plan and on this account we welcome at any time further comments on any of these topics or any others taken up in these columns. We hope to make it plain that this section is maintained for the free exchange of "new business getting" ideas and that new business men and all others interested are most welcome to avail themselves of the frequent use of these columns to discuss among themselves matters of mutual interest.

During the past year we have endeavored to take up new business matters more in detail. We have attempted to analyze the relations between central station and customer, considering the details of service regulations, contract forms and the handling of such matters as deposits, complaints, delinquencies and the like. We also considered campaigns for special purposes, such as the introduction of appliances, the securing of summer loads and new and old schemes for Christmas merchandising. Some attention was also given to methods used in meeting competition of other than electric illuminants. Another interesting feature of the year's work was the considerations of engineering as applied to salesmanship, or as it might be termed, "specialized business getting." The fields of the illuminating engineer, the power engineer and the sign specialist were considered, showing how the services of each are valuable in securing new business along these lines.

Another branch of the central station industry which is an important consideration in the securing of new business, was taken up, namely those factors which affect service conditions such as load factor, diversity factor and power factor. In this connection an analysis was made of different kinds of business with a view to determining the conditions under which such loads can be profitably taken on as well as methods by which the more profitable classes of business can be secured.

In addition to the presentation of these topics by the editor of this department, we were assisted and permitted to present a large number of comments and discussions from new business men through the country. We take this opportunity therefore to openly express our appreciation to these contributors for their hearty co-operation and extend an invitation not only to them but to all of our new business readers, to assist us during the coming year by frequently giving suggestions, comments and criticisms. Those we are indebted to for this assistance during the past year are:

Washington Devereaux, Philadelphia Fire Underwriters, Philadelphia, Pa.
L. J. Wilhoite, Chattanooga Ry. & Lt. Co., Chattanooga, Tenn.
B. W. Mendenhall, Utah Lt. & Ry. Co., Salt Lake City, Utah.
R. B. Mateer, Great Western Power Co., San Francisco, Cal.
Eugene Creed, Lexington Utilities Co., Lexington, Ky.
W. R. Collier, Ga. Ry. & Pr. Co., Atlanta, Ga.
A. H. Sikes, Athens Ry. & Electric Co., Athens, Ga.
C. A. Knight, Meridian Light & Ry. Co., Meridian, Miss.
F. T. Williams, Heating Device Specialist, G. E. Co., Atlanta, Ga.
Thomas Rhodes, Consumers Electric Lt. & Pr. Co., New Orleans, La.
W. E. Clements, New Orleans Ry. & Lt. Co., New Orleans, La.
C. E. Ousley, Kentucky Electric Co., Louisville, Ky.
C. L. Owen, Springfield Lt., Heat & Pr. Co., Springfield, Ill.
W. C. Duncan, Bay City Ice & Lt. Co., Bay City, Tex.
G. W. Hogshead, Roanoke Ry. & Electric Co., Roanoke, Va.
F. W. Smith, United Electric Lt. & Pr. Co., New York City.
Clare N. Stannard, Denver Gas & Elec. Lt. Co., Denver, Colo.
H. N. Sessions, Southern Calif. Edison Co., Los Angeles, Cal.
E. H. Mulligan, Southern Calif. Edison Co., Pasadena, Cal.
Frank Hammond, Birmingham Ry., Lt. & Pr. Co., Birmingham, Ala.
E. D. Craig, Savannah Electric Garage & Tire Co., Savannah, Ga.
C. E. Michel, Union Electric Lt. & Pr. Co., St. Louis, Mo.
E. S. Roberts, Savannah Electric Co., Savannah, Ga.
T. W. Peters, Columbus Railroad Co., Columbus, Ga.
Douglas Burnett, Con. Gas & Electric Lt. & Pr. Co., Baltimore, Md.
L. W. Carnagy, Transformer Specialist, G. E. Co., Atlanta, Ga.
Stewart C. Irby, Hattiesburg Traction Co., Hattiesburg, Miss.
William F. Wallace, Rochester Ry. & Lt. Co., Rochester, N. Y.
W. G. Morgan, San Antonio Gas & Electric Co., San Antonio, Tex.
S. H. Alexander, Public Service Electric Co., Newark, N. J.
Arthur Williams, New York Edison Co., New York City.
W. L. Southwell, Macon Ry. & Lt. Co., Macon, Ga.

A review of the last twelve issues will show that the subjects discussed by the above new business men, frequently have to do with the topics assigned for particular numbers, yet we believe the greatest value of the comments and suggestions lies in the fact that in almost every case actual experience and results of new business methods were brought out. On this basis all new business men have interesting things to say—let's all have a "say" during the coming year.

OUR PLANS FOR 1914.

During the coming year, we intend to go, as far as practicable still further into the practical details of new business getting and take up those subjects that seem to be prominent in the discussions of get-to-gether meetings of central station men, both large and small. Occupying a prominent place in these discussions is the subject of relationship between company and employe, including accident prevention, beneficial organizations, liability insurance, pensions, welfare work and the like. We intend to take this matter up in the next issue and urge all who can, to furnish results of experience.

In the March number we desire to consider further, commercial department forms and accounting and such allied matters as proper forms for bills, stock records, trouble records, meter readings, etc.

In the April number (Annual Current Consuming Device Number) we shall be glad to have comments on the subject of appliances and appliance exploitation, as well as on fan campaigns and moving picture loads, etc.

In the May number we plan to take up the ever interesting subject of ice making and refrigeration. Information on combination properties, as well as data on methods of ice-making by use of central station current will be appropriate for this issue. Electro-chemical and electro-metallurgical processes will also be discussed at this time.

In the June number (Annual N. E. L. A. Convention Number) we intend to present a review of matters pertaining to regulation by Public Service Commissions. Provisions of the various statutes in force will be studied with comments on important decisions that have been rendered. Opinions on this subject from any standpoint will be most welcome. Topics for the remainder of the year will be announced later.

In as much as these remarks have to do with the work of a new year, which has every reason to be a prosperous one, this is our New Year's toast:

Here's to those whom you serve,
Here's to those who serve you,
And here's to those who serve those whom you serve
And to those who serve those who serve you.

Current Topics and Events in Central Station Fields.

Two interesting papers have been presented at recent conventions relating to the electrification of steam roads. Mr. H. M. Hobart of the General Electric Company points out the superior advantage in economy which electrically propelled trains have where the traffic is dense. Even long haul and freight services are possible under certain conditions. He also gives it as his opinion that in many cases the railroad company can purchase current cheaper from central stations along the right of way, than they can manufacture it. He recommends 2,400 volt direct current operation with substations about 30 miles apart. In such service, two 1200 volt motors are used in series, with two pairs permanently in parallel, since on such service there is little advantage in series-parallel control. Among the reasons for greater efficiency, we may mention the ability of the central station to run condensing, the use of cheaper fuel and the like.

Mr. Kahler, of the Oregon Short Line shows advantages from an operating standpoint, and gives figures showing a saving of from 9 to 11 per cent over steam, using 15-cycle, single-phase current. He points out the better overload characteristics of the electric motor, hence less grading. Attention is also called to the advantages resulting from the common use of the right of way for railway tracks and transmission lines. He advocates a higher voltage than Mr. Hobart, giving 5,000 volts as well within standard practice. At the same time he expresses the conviction that the development of the steam locomotive has by no means reached its limit.

The interest in railway electrification has resulted in a trip to this country by officials of the London, Tilbury, and Southend Railway, who are considering the electrification of 70 miles of road.

Massachusetts has 951 electric vehicles of which 562 are passenger and 389 commercial trucks.

The Commonwealth Edison of Chicago has an annual revenue of $200,000 from charging electrics.

The recent electric "vehicle salon" in Boston was well attended and resulted in the sale of many cars. Twenty-nine different vehicles were on exhibition.

Denver now has nearly 900 electric vehicles. A special charging rate of 3c per kw-hr. prevails, and no doubt has greatly stimulated their use.

The Boston Edison is carrying on a house wiring campaign. The schedule of price per outlet and fixtures seems to be unduly complicated.

The Southern California Edison has 90,000 customers, with 85 per cent of them using electric irons, and yet the company is not satisfied! They insist that the other 15 per cent shall fall in line. At present they are offering 50 cents each for all the old sad-irons turned in and already have a scrap pile of no mean proportions. They are also booming the percolator, and offer $1.00 each for all old coffee pots. This is good business.

Pittsburg has 2,800 "Excess Indicator" customers and the campaign is still on. They also offer a rate consisting of a fixed charge based on the number of "active" rooms, plus a five cent meter rate. This has been successful in getting good sized residences, and encourages the use of heating and cooking devices.

A recent suggestion which looks good, is for the central station to install and light a show case in some attractive drug store, giving the druggist a commission on any sales. The usual line of devices should be displayed.

At Muncie, Ind., the central station advertises, free of all charge, all vacant dwellings which are wired for electricity.

Jacksonville, Fla., now offers a 2 cent cooking rate.

Recent decisions of public service commissions indicate that they do not regard "going value" as capitalizable.

Legal decisions in a recent action are to the effect that a high voltage transmission line is not of necessity dangerous to life or property.

Germany possesses some large central stations. One recent plant is of 40,000 Kw. capacity, and another contains a single turbo-alternator unit of 20,000 Kw.

The Brooklyn Edison Company which has conducted a profit sharing plan during the past three years, has just decided to continue it during the coming year.

The Madison Gas and Electric Co., of Wisconsin, has made the third reduction in rates in three years.

It pays the central station to assist in the selection of power equipment. A mill with a mixed assortment of induction motors of all sizes was found to have a power factor of 60 per cent. By rearranging the motors so as to make them correspond more closely with the load, the power factor was raised to 85 per cent.

Ozone is now said to be used in hatching chickens—what next?

COMMENTS FROM READERS.

Rufus G. Gentry, Assistant Commercial Manager, Denver Gas and Electric Light Company, Denver Colo., Outlines Successful 1913 Campaigns.

In the spring of 1913, the commercial department of the Denver Gas & Electric Light Company inaugurated a campaign for the sale of gas and electric consuming appliances on a more elaborate and strenuous basis than ever before. We arranged one dozen groups of appliances, with three appliances in each group and in each instance included an Ohio vacuum cleaner. We totaled the selling price of these appliances and deducted therefrom about 20 per cent, or to be exact, $11.00, issuing a coupon for that amount, and stating the conditions of the sale and the groups, etc. These coupons were distributed to all our customers and prospects, with instructions that if presented when purchasing either of these groups, that one would be received as $11.00 on the payment of the bill, and further, we made a small discount for cash, or the privilege of small monthly payments on their bills.

This plan met with a great deal of interest on the part of our consumers and responses received aggregated a sale of more than 1,200 appliances in a thrity-day period. We received right away the added load on our stations for gas and electricity, besides a profit on the appliances sufficiently ample to absorb the discount allowed and make a splendid net profit on the sales. There are a number of good features involved in this plan, as follows:

First, the selling talk is not much greater than necessary with either one of the three articles sold separately, thereby saving of time and annoyance to the customer.

Second, there is a great saving in time and expense in keeping the account collected, etc.

Third, the time is rapidly approaching when central stations will have succeeded in supplying their customers with larger consuming appliances and therefore to make the commercial work and the selling of appliances more effective and efficient, it is imperative that we group together the smaller consuming devices to maintain the proportionate increase of revenue of our stations.

In connection with the above sale an electric truck was used in a most effective manner, devoting one-half of the day to taking out groups, demonstrating them at the homes and the remaining portion of the day the truck was kept busy delivering the appliances at a very small cost per appliance.

This company also has a large fleet of electric trucks, ranging in capacity from 700 pounds to 8,000 pounds. These trucks are doing excellent service and displacing a number of horses. They are used for the delivery of coke at a much less cost per ton, making quite a saving over horse-drawn delivery. We have two trucks that make lamp renewals; several setting electric and gas meters; two large trucks for the delivery of freight and warehouse merchandise; and we also have electric trucks in the line construction department, trouble department, lamp trimming department and the delivery of small electrical appliances, which are frequently used for demonstrating purposes. We have been successful in using electric trucks for any and all purposes that horse-drawn vehicles were used. Also three electric roadsters for the use of foremen.

This company also maintains a department of storage battery and vehicle engineering under the supervision and direction of Mr. E. M. Jackson, which department devotes its entire time to solicitation for the sale of electric trucks as well as inducing the garages to so handle the vehicles and care for them that the consistent performance known to be possessed is always obtainable by the owner.

G. P. Garrett, Empire District Electric Company, Joplin, Mo., Describes Successful Holiday Campaigns.

During the holiday season just past, we used with good results, extra newspaper and electric lighted bill-board advertising to attract the attention of the business men, and the public in general, to specially decorated display rooms. By special arrangement, we were able to make unusually low prices on many appliances, which has caused them to be placed in service in large numbers. Advertising souvenirs of electric tops and "mocking-birds" were distributed among the children throughout the district, as another means of attracting attention to the special sales, and bargains in modern electric appliances. Our office building was made attractive, the front being studded with hundreds of lamps, arranged in an ornamental design, which brilliantly lighted the street for a hundred feet (or more), in either direction at night. The offices are elegantly furnished, and our large show-windows and display room changed and rearranged regularly, keeping the very latest apparatus and appliances constantly before the eyes of the public.

Our organization is necessarily divided into several departments, which co-operate together for the best interests of the business. The new business department has the cities and the entire mining district divided into sub-districts, with regular salesmen working allotted territory, on a salary and commission. In addition to this, we have also special apparatus and appliance salesmen, electric sign designers, etc., working in harmony with the regular salesmen at all times.

The company spends a large sum of money for newspaper advertising, which is kept up regularly and on an extensive scale when there are special gatherings or meetings of out-of-town people to be held. Every available opportunity is taken advantage of to keep the name of our company and its business fresh in the mind of the public, and liberal contributions and donations to all worthy causes have proven their value, many times over.

W. E. Clement, Commercial Agent, New Orleans Railway & Light Co., New Orleans, La., Describes Portable Electric Installation for Use in Unwired Houses.

The accompanying illustration shows a portable electric installation which the writer has devised and is using successfully to make a cheap and quick connection in houses not provided with electric wiring. Inasmuch as a large majority of homes in the older Southern cities are in this class, the importance of such a device is readily apparent to the average new business man. The electric iron, which has scored such a triumph in wiring houses and is truly the "backbone" of the heating device business, will be exploited by means of this device and on account of the low cost and ease of installation of the whole equipment, we believe it will enable us to make a number of new installations.

The equipment is known as the Electric Wall Cabinet, and has been made up in a considerable number by the Electrical Development Company and passed on by the local representatives of the Electrical Underwriters. Applications for patent rights have been filed with the patent office and preliminary papers issued by the commissioner. As shown in the illustration, the equipment consists of an iron box in which is installed an induction watthour meter, the equipment being installed in the cabinet in our meter shops and the entire outfit taken to the customer's premises and installed by simply driving a nail or screw into the wall, nine or ten feet above the floor and hanging the equipment as shown in Fig. 1. A screw at the bottom holds the equipment plumb. The boring of two holes through the wall, placing the required porcelain tubes in them, and connecting the wires, finishes the work of installation.

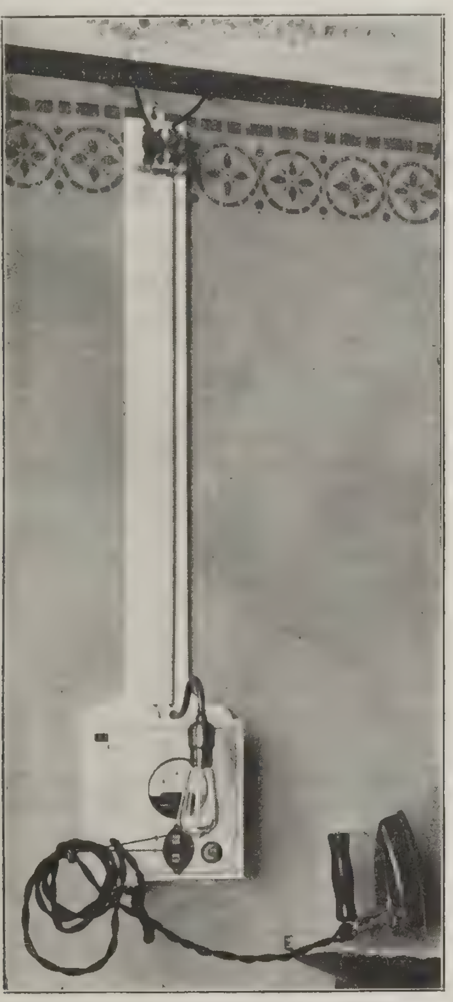


FIG. 1. SHOWING INSTALLATION OF ELECTRIC WALL CABINET.

The cabinet complete, equipped with a standard $3.50 electric iron, six feet of flexible cord and a 40-watt tungsten lamp and bracket is installed complete for $9.00. The circuit is opened and closed by a push button switch mounted at the left of the cabinet near the top as shown. A pilot light mounted inside the cabinet indicates when the iron is in circuit through the red glass "bull's eye" shown at the right of the swinging bracket. The entire outfit can be easily removed from the wall and moved from one installation to another, if necessary, at a minimum cost. This device, together with the writer's electric service table described in the April issue of *Electrical Engineering* facilitates the handling of connections in unwired houses in a very satisfactory way.

A Unique White Way at Carthage, Mo.

BY GEO. P. GARRETT.

It is clear to any one who has followed the progress of electrical development, that a revolution in the illumination of public streets and thoroughfares is under way. The larger cities have made great strides along this line and many of the smaller cities are adopting modern and novel schemes of so-called ornamental street lighting. A decidedly attractive and interesting system has recently been installed at Carthage, Mo., as shown in the accompanying illustrations.

The streets were previously lighted by means of 6.6-amp., series incandescent carbon filament lamps, 6.6-amp., inclosed arcs, multiple a. c., arcs and arches or festoons of small incandescent lamps suspended diagonally over the street crossings.

Before deciding upon the white way installation, an extensive study of the situation was made to determine what constituted a system that would be attractive in the day-time and give an effective and even distribution of light by night. The Business Men's League became interested and the City of Carthage, through the Board of Public Works, made a proposition to them, offering to pay for all under-ground wiring, lamps and glass-ware; to connect up, maintain and furnish all current necessary for illumination, for "all time to come," providing that the business men would purchase, erect and wire all clusters to be installed in the business section.

A committee, headed by Mr. R. E. Baird, of The Empire District Electric Company, was appointed by the Business Men's League to confer with the property owners and business men; also to make designs and specifications of both stone and cast iron standards, and submit same to the local quarries and foundries for bids to furnish same by contract. The business men were divided upon the adoption of stone or cast iron standards, owing to the high market value of the stone, but when they learned that the cost of stone standards would not exceed that of cast iron more than fifty per cent, the stone with five-light cast iron tops were readily adopted. The Carthage "white way" is practically a "home-made" product; the stone being supplied by the Carthage Quarry Co., the cast iron tops by the Carthage Foundry & Machine Works and the erecting and wiring was done by local contractors.

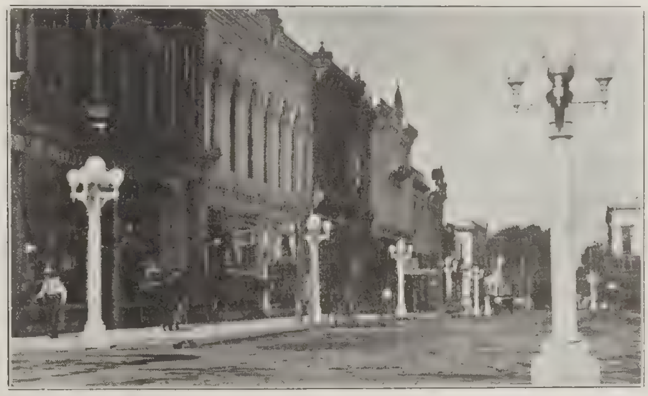


FIG. 1. STREET AT CARTHAGE, MO., SHOWING INSTALLATION OF STONE DECORATIVE STANDARDS.

The dimensions of the stone base of the standard adopted is 20 x 20 x 12-in. with the upper edges beveled. The second base is 14 x 14 x 5-in. and the base of the round column is 12-in. in diameter and 3½-in. thick with rounded edges. The round column is 7 ft. in length with 1-in. flange at the base, which is 10½ in. in diameter and tapers to 8 in. in diameter at the top.

The cast iron cluster is of heavy design and weighs 350 pounds, complete. The body is of hexagon shape, and two panels of the body are removable to provide access to the fused cut-outs, which are located in the body of the cluster, instead of the base of the standard. The body of the cluster fits well over the top of the stone column, forming a ¾-in collar around it, and the 1¼-in. conduit passing from underneath the walk, up through the center of the bases and column to the body of the cluster, securely clamps the fixture by means of heavy flanges and lock-nuts.

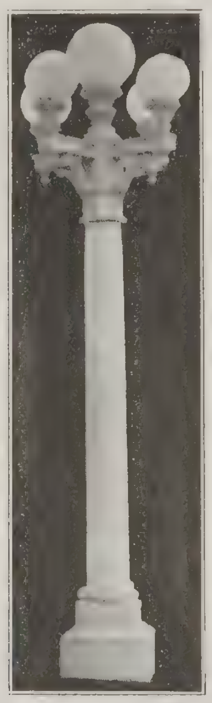


Fig. 2. The Carthage, Mo., Stone Lighting Standard.

To prevent rust or other damage from the weather, the cluster is given several coats, both inside and out, of specially prepared mica paint, which is nearly white, to match the color of the stone. The center light of the cluster is 11.5 feet above the walk and the out-side lights are 11 feet above the walk; the arms of the cluster measuring 36¼-in. from center to center of the holders. All lights are erected in an upright position, but may be made inverted by merely changing the holders to the lower side of the arms, for which provisions were made when moulding.

A 60-watt tungsten lamp enclosed in a 12-in. opalescent outer globe is used for each of the four outer units and the center unit consists of a 100-watt tungsten lamp enclosed in a 16-in. opalescent globe. The under-ground wiring consists of two circuits of lead-covered cable laid in conduit. One circuit supplies the four outside lamps of each cluster, which burn on a mid-night schedule, and the other circuit supplies the top lamps, which burn all night.

A fair idea of the day-light appearance of these ornamental clusters may be had from the accompanying illustration, but their real beauty can only be fully appreciated when seen illuminated, at night. Mr. R. E. Baird, of The Empire District Electric Company at Carthage, who designed and superintended the installation of this unique white way, has been appointed as agent by the Carthage Quarry Co., and the Carthage Foundry & Machine Works, to represent them in promoting the sale of this type of cluster standards.

New Electric Business in Louisville, Ky.

During the week of November 10 to 15, the new business department of the Louisville Gas & Electric Company secured contracts calling for 627 horsepower of new electrical power business. The Louisville commercial department has been re-organized and among the changes made is the discontinuation of selling appliances, motors, etc. The electric appliances formerly carried by the company have been sold to the local contractors and in place of the merchandise display maintained by the company, five contractors have individual displays in glass cases (furnished by the company) in the front of the company's office. These displays are in charge of the company which demonstrates the appliances and takes orders for the contractors. A display of gas ranges, heaters and other appliances, furnished by the agents, is also exhibited.

The company has contracted with the H. M. Byllesby & Company, under whose management the Louisville properties are operated, for the extension of their Waterside station. The immediate extension will consist of eight 500-horsepower boilers and two 5,000-kilowatt turbines, together with coal handling machinery and accessories.

Electric and gas connected load figures from all of the Byllesby properties show appreciable gains as of October 1st, compared with a year before. These properties are now serving upwards of 212,000 customers, including 6,624 telephone, water and steam heat customers. During the year the number of electric lighting customers increased 15 per cent; power customers 23 per cent and gas users 6 per cent. While the lighting load grew 18 per cent or to 149,000 kilowatts, the electric power business increased to 105,000 kilowatts, a gain of 29 per cent. The total of 256,670 kilowatts connected for all purposes exhibits a 20 per cent advance.

Lighting Rates in Large Cities.

During the recent adjustment of rates in St. Louis, a study was made of the rates for lighting in the larger cities and the following data secured as the average rate for this service during 1912. The rate for Boston includes the electric railway energy sold at a rate considerably less than the average.

Location.	Total Commercial and Street Lights per K. W. H. in cents
Chicago	5.10
Philadelphia	5.25
Boston	5.38
Brooklyn	6.00
St. Louis	4.78

In the February, 1913, issue of *Electrical Engineering*, we published the rates then in force for all important southern cities. The rate in Atlanta is 7 cents down to 5.4 for lights, depending on current consumed; in Birmingham, Ala., the lighting rate is 12 to 6 cents; in Memphis, Tenn., 10 to 8 cents; in Chattanooga, 12.5 to 6.5 cents; in Nashville, 12 to 7.2 cents; and in Richmond, Va., 9 to 5.4 cents. With these charges no city can afford to even have dark alleys, much less poorly lighted streets. Residence lighting is having a steady growth and a number of Southern stations are now carrying on or planning to start in the near future active campaigns to secure the small consumer, such as found in mill and factory districts of the South.

Questions and Answers from Readers

Readers are invited to make liberal use of this department for discussing questions, obtaining information, opinions or experiences from other readers. Discussions and criticisms on answers to questions are solicited. However, editors are not responsible for correctness of statements of opinion or fact in discussions. All published answers and discussions are paid for.

DISTRIBUTION OF LIGHT FROM ORNAMENTAL WHITE WAY POST.

Editor Electrical Engineering:

(423) I would like some reader to present in your columns a distribution curve of light flux from an ornamental white way post of 5-100 watt globes, one upright and four pendant. I desire this curve to compare with the distribution curve for a luminous arc lamp of same candlepower. The distribution curve should show the light flux in plane of the four pendant lamps. W. P. E.

WHY DOES SERIES TRANSFORMER ON OPEN CIRCUIT BURN UP?

Editor Electrical Engineering:

(424) Please explain why a series transformer will burn up if the ammeter is disconnected and the secondary left on open circuit, but will operate satisfactory while the ammeter is connected or the ammeter terminates short circuited? V. K. S.

REWINDING SMALL MOTOR.

Editor Electrical Engineering:

(425) The writer has a small bipolar battery motor with one field coil 2¼ inches long and a winding depth of about ¾-inch. The armature has 6 slots with a commutator of three segments. Kindly advise the number of turns and size of wire required to rewind this motor for 110 volts. Give a diagram of armature winding showing connections. F. L. Wood.

WHY NOT OPEN FIELD OF LARGE MOTOR IN OPERATION.

Editor Electrical Engineering:

(426) The writer knows that it is certain ruin to a large direct current motor to open the field circuit while the motor is in operation. Will some reader explain what causes the motor to flash over at the brushes and burn up? Also explain why a series motor has a tendency to speed up and throw its armature to pieces when the entire load is removed, such as occurs when a belt slips off. W. A. B.

WHAT IS NATURE OF MAGNETIC BLOWOUT?

Editor Electrical Engineering:

(427) What is the nature of design of a magnetic blowout and how does it operate? What factors determine its design? W. A. C.

HEATING A BRICK FACTORY BY STEAM.

Editor Electrical Engineering:

(428) I would like to get information or the benefit of a discussion through your columns on an estimate of the amount of steam, and comments on the system to use in heating a brick factory building under the following conditions: Two fire tube boilers, having a normal rating of 55 horsepower each, and worked at a pressure of 100 pounds gage, are used for an engine and heating and drying systems. The engine is of the non-condensing, 4-valve type and consumes approximately 28 pounds steam per Ihp. hour. The load varies from 90 to 115 horsepower.

The heating system throughout the factory is in very poor shape. Returns are provided, but no vacuum pumping system is used and the drips go to a well and are pumped finally to the boilers. From a rough survey made, I find approximately 2,086 square feet of the 1-inch pipe used for heating, the factory having about 500,000 cubic feet of surface. It has always been the custom whenever steam was needed for heating, to use live steam at full boiler pressure, and the system is fed from 1 and 2-inch pipe. In winter, with the temperature anywhere below freezing, for the needs of the engine, dry kiln and heating system, about eight tons of coal are used per day. The factory runs 10 hours a day and dryer and heating system is on to some extent during 24 hours.

The writer would like an opinion expressed on the relative steam consumption of such a heating system using live steam and one as ordinarily used, at say, 15 to 20 pounds. All other things remaining the same, could one expect as much heat in the one instance as the other? When and why is use made of such a high pressure on a heating system? If a test showed that 40 to 50 per cent of the indicated engine load in the factory to be shafting and transmission loss, could a saving be made by installing a low pressure gas fired boiler for the dry kiln and heating system, and so far as reasonable, use individual motor drive? Gas sells for 10 to 16 cents per 1,000 cubic feet, and coal at $1.60 to $1.75 delivered per ton. Electrical energy costs from 1 to 3 cents per Kw.-hr. Any further information needed that would be of use in giving the writer an opinion will be gladly furnished.

F. G. Flickinger (W. Va.)

2,200-VOLT LINE VS. 11,000-VOLT LINE ON BASIS OF CONSTRUCTION COST.

Editor Electrical Engineering:

(429) The writer desires relative costs for building a transmission line for 2,200 volts and 11,000 volts. The conditions are as follows: Wooden poles are to be used—30 feet. Line to be 3-phase, 3-wire and transmit 400 Kw. at 80 per cent power factor, with a drop of not more than 6 per cent. Distance one way 8,000 feet.. Receiver voltages to be 2,200 and 11,000. Roughly, what energy loss exists for each Scott connection of transformers using 200 Kva. capacity? F. S. F.

REVERSING FIELD OF D. C. EXCITER.

Editor Electrical Engineering:

(430) The writer has two direct current generators used as exciters for two alternating current generators. These exciters are 5 Kw. and 6.5 Kw. compound machines, operating at 110 volts, with equalizer connections for operation in parallel, when the alternators are operating in parallel. Please advise the reasons and the conditions under which the field of one of these excitors becomes reversed. Also advise the proper method to bring the field to its proper magnetization. Must the equalizer connection be disconnected, in the process? Must the machine be running when the field is being reversed to proper state.

V. K. Stanley.

CONNECTIONS FOR 220 AND 440 VOLT MOTORS TO DELTA CONNECTED TRANSFORMERS.

Editor Electrical Engineering:

We have three type WB Maloney transformers, single-phase, 25 cycle, 2300 volts to 440 volts with primaries and secondaries delta connected. Each transformer has four terminals on the secondary side as shown in Fig. 1, the two middle leads being joined together. Several days ago I received a 3-phase, 220 volt motor with instructions to connect it to leads A—4 and 5, the 440 volt motor to remain on leads 1, 2 and 3. The writer was of the opinion that there would be a difference of potential of 440 volts between leads 4 and 5; 5 and 6; 4 and 6, but upon testing with voltmeter found 220 volts between leads, A-B; B-C; D-E; B-E; E-F; G-H; E-H; H-I, and B-H. The 220 volt motor runs on leads 4-5 and 6 as well as on A-4 and 5.

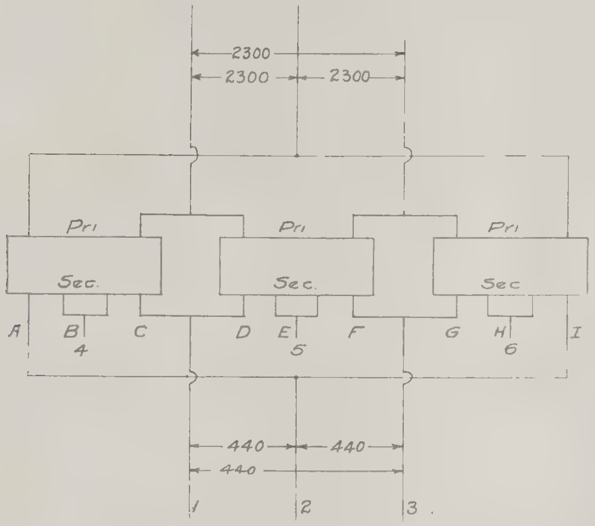


FIG. 1. CONNECTIONS OF THREE TRANSFORMERS FOR 220 AND 440 VOLT MOTORS.

Please explain the phase relations for these connections. Is it good practice to operate motors of different voltages in this way? The 220 volt motor is 5 Hp, is there any unbalancing of the transformers on either of the connections shown? T. C. M.

Trouble in Operating Rotary Converters. Ans. Ques. No. 396.

Editor Electrical Engineering:

The writer does not believe that the trouble in the operation of rotary converters mentioned in question No. 396, is caused by the poor distribution of the A. C. conductors in conduit. The questioner does not state whether the conduits are iron or terra-cotta. It is quite likely if the rotaries are large ones, there would be excessive heating of the iron conduit. From the statement that the rotaries are three-phase, it would naturally be assumed that they are small ones, and that such heating would not be serious. The writer is led to suspect that the operators are not correctly starting these rotaries. The proper method of starting is with the rotary field switch open, closing the compensator or auto transformer on the starting side. As the rotary comes up to speed, it will be noticed that the direct current voltmeter first oscillates rapidly and gradually the beats slow down until the machine locks into step, at which time the voltmeter will indicate either a constant deflection, positive or negative, depending on whether it has locked into step correctly or reversed. If the D. C. meter shows reversed condition, the double throw field break up switch should be closed into the bottom throw for an instant, thereby making the rotary slip a pole. If it should be of the right polarity, the field switch can be immediately thrown into the up throw, the rotary still running from the starting taps of the compensator. The rotary can now be thrown over to the running side of the compensator, and if this is quickly done there is practically no possibility of the rotary reversing its polarity. If the attempt is made to throw the rotary from the starting to the running side of the compensator without first closing the field switch and giving the machine excitation, an extremely heavy rush of current is likely to take place when the rotary is thrown from the starting to the running side.

There is a remote possibility that the collector rings are connected to different phases on the starting taps from those on the running side of the compensator. Numbering the rings, 1, 2 and 3, beginning at the A. C. end pillow block, obviously the starting taps on phase No. 1, likewise the line of phase No. 1, should go to ring No. 1 and so on for phases 2 and 3. If, on starting, taps from phases 1, 2 and 3 go in the order named t othe correct rings and on the running side of the compensator, phase No. 1 goes to ring No. 2, phase No. 2 goes to ring No. 3 and phase No. 3 goes to ring No. 1, it is possible that the rotary might pull into step with the direct current voltage reversed when thrown over onto the running side, as the phase rotation would still be the same, but the relative position of the armature would move forward 120 degrees. The writer would suggest that the connections be carefully examined for such an occurrence. The sudden flow of current with such connections would be likely to knock the automatic oil switch open, if it is not set for a great many times normal load current.

The writer would recommend changing the wiring of the rotary so that one wire of each phase is in the same conduit, as the effect of the wiring at present is to produce a slight voltage unbalance on the A. C. collector rings, causing a poor distribution of current in the armature and likely spotting of the commutator at three equi-distant points, assuming a 6 pole, 1200 revolution, 60 cycle rotary.

H. E. Bussey (Ga.)

Series and Parallel Armature Windings. Ans. Ques. No. 399.

Editor Electrical Engineering:

There are two general classes of windings used on drum armatures, one of these called the series or two-circuit winding, and the other a parallel or multiple-circuit winding. Either of these may be simplex, duplex or triplex; that is, it may have one, two or three conductors in parallel. Fig. 1 shows a series winding. Starting from conductor No. 1, we go to No. 14, then to 28, 42, 3, 16, 30, 44, 5, etc. Conductors No. 2, 4, 6, 13, 15, etc., are not shown. It will be noted that in this winding, the connections go from pole to pole, adding up small increments of voltage until the complete circuit of the armature has been made. It will further be noted that the progress is always in a forward direction around the armature, and hence this winding is also termed wave winding from the appearance of the development.

In Fig. 2 a parallel or multiple circuit winding is shown. In this case starting from conductor No. 1, we go to 14, then back to 3, then forward to 16, then back to 5, then forward to 18, etc. From this, it will be seen that the voltage between brushes is caused by the passage of the

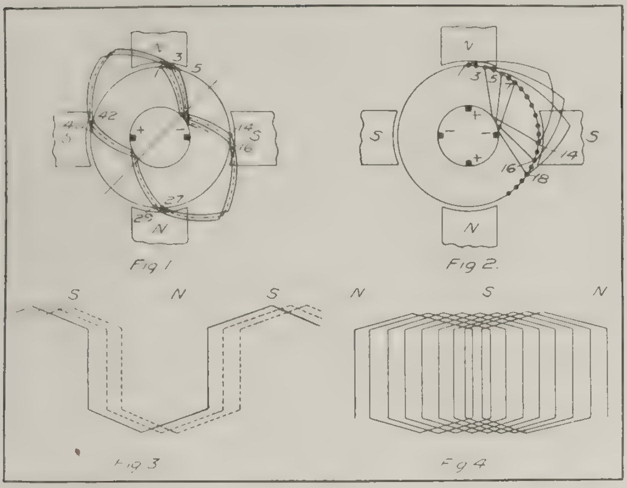


FIG. 1. SERIES WINDING FOR D. C. ARMATURE. FIG. 2. PARALLEL WINDING FOR SAME. FIGS. 3 AND 4 SHOWING DEVELOPMENTS OF SERIES AND PARALLEL WINDINGS.

conductors under a single pair of poles. The winding is termed multiple-circuit because there are as many paths for the current from plus to minus brushes as there are poles, while in the series or two-circuit winding, there are only two paths for the current, regardless of the number of poles. The parallel winding, from the appearance of its development, is termed lap winding. In the first case, only two brushes are needed to collect the current from the commutator, while with the parallel winding there are as many brushes as poles required.

Two series windings super-imposed, constitute a series duplex winding. In Fig. 1, the dotted lines might represent another winding added to the armature, in which case there would be now four paths for the current, instead of two. The character of the winding, however, is not changed, since two identical circuits are simply thrown in parallel. The same thing is true of the parallel windings, since there may be two, three or more conductors forming parallel paths from brush to brush. In the case of duplex windings, there are twice as many paths as poles, for triplex windings, three times as many paths as poles, etc.

The entire subject of armature winding, while based on simple principles, cannot be thoroughly understood without a good deal of patient study. As a help along this line, I would suggest a careful study of ARMATURE CONSTRUCTION, by Hobart & Ellis, which can be secured from D. Van Nostrand Company, New York City, at a cost of $4.50.

Calculations to Determine Size of Wire for Motor Circuit. Ans. Ques. No. 406.

The size of wire to run for any motor load is sometimes determined by the drop, sometimes by the current-carrying capacity, and sometimes by the mechanical strength; that is, a No. 12 wire will carry the current for a 3½ Hp., 220-volt motor which, at full load, is about 15 amperes. However, the drop would be about .05 volts per foot run. For a short distance of 100 feet or so, this would not be serious, but in case the motor were located several hundred feet from the supply, the loss of power would be considerable, and it would probably pay to use a larger wire.

In running wires outside, No. 10 might be used for such a motor, but No. 8 would be better from a mechanical standpoint. For inside wiring, No. 10 is about the smallest size that should be used for any motor. In the example given of 25 Hp. total capacity of 220-volt motors, with load factor and diversity factor unknown, we may assume 20 Hp. to be the maximum total load, in which case the current would be about 84 amperes. For such current the underwriters would require No. 4 weather-proof wire outside, and No. 2 rubber-covered wire inside. The drop over 200 feet of No. 4 wire would be about 8.4 volts, or about 4 per cent, which would not be considered excessive. Whether it would pay to spend more money for copper in order to reduce this drop, must be decided by the customer. If it is likely that some additional load would be added to the circuit soon, it might be well to use No. 2, which would give the drop of only 5 volts with full load current. For the inside wiring, No. 2 wire would be likely to give satisfactory service for distances likely to be used in a small factory.

In case the motors are to be placed on separate circuits, the sizes specified by the underwriters would probably be satisfactory, both from the standpoint of mechanical strength and voltage drop. A 10 Hp. motor fully loaded draws about 42 amperes, and a 5 Hp. about 21 amperes, and this, according to the tables, would take No. 6 and No. 10 wire, respectively. This would be large enough mechanically, and it is not likely that an excessive drop would occur within the limits of the ordinary shop.

Transformer Connections for Different Voltages. Ans. Ques. No. 408.

The connections for lighting and transformers have become pretty well standardized. There are two general types of transformers, one designed for lighting, and the other for power service. Each has two primary windings and two secondary. The primaries are arranged for 1,100 or 2,200-volt circuits, being placed in series for 2,200, and in multiple for 1,100 volts. The secondaries are arranged to give 110 or 220 volts for lighting, and 220 or 440 volts for power. For lighting service, the secondary coils are usually connected in series and the middle point grounded. The three wires are then run as a 110 to 220-volt circuit in the usual manner. The power transformers are connected in identically the same way, except that the secondary coils may be connected in parallel for 220-volt circuits, or in series for 440 volts. Lighting companies prefer 220-volt motor circuits because, while they are not quite as economical in copper, they can supply such circuits from their regular lines of lighting transformers, and are thus not compelled to carry a double line.

Most manufacturers of transformers now are providing 10 per cent taps on the primary side to be utilized in outlying districts where it is necessary to boost the voltage. In using the well-known Scott connections for 2 to 3-phase transformation, it is usual to use two standard transformers, one having a tap at the middle of the secondary winding and the other at 86 per cent thereof.

Single-phase current can be taken from any two wires of a 3-phase circuit, but it is preferable to take single-phase current from 2-phase distribution lines, on account of it being easier to balance the circuits.

Reactance in an Electric Circuit. Ans. Ques. No. 409.

Reactance is that property of an electric circuit by virtue of which it opposes, not the passage of current, but any change in the current value. Briefly, this is produced by the counter emf. set up in the conductor when cut by the lines of magnetic force as they may be conceived to expand or collapse on change of current. Obviously in the case of a coil with many turns and with high frequency alternating current, the reactive voltage may reach a high value while if a steady direct current be passed through the same coil, there being no varying field, the only opposition to the flow of current comes from the simple ohmic resistance, which may be very low as compared with the inductance.

It is impossible to get a pure reactance, because all conductors have some resistance. The emf. taken up by the resistance is directly opposed to the impressed voltage, while the inductive emf. is 90 in phase relationship. Therefore the total resisting effort is not the arithmetical, but the geometrical sum of the resistance and the reactance, and is termed the impedance. For instance a coil having a resistance of 5 ohms, and a reactance of 100 ohms, would have a total impedance of about 100.1 ohms. Such a coil would possess very different behavior on direct and on alternating current.

Power reactances are used in power houses to limit the possible short circuit currents. Under normal operation they offer very little opposition to the current flow, but exercise a noticeable choking effect in case of short circuit.

A. G. Rakestraw.

Reactance in an A. C. Circuit. Ans. Ques. No. 409.

Editor Electrical Engineering:

The use of the term reactance by Mr. Meiderhiser in question 409 of the November issue is rather confusing, yet a common use of it. Power reactance is a poor name for the device to which he refers, for it tends to lead the non-technical reader to consider that the term reactance refers to a physical device rather than to a property of such a device. The "power reactance" is simply a coil or coils of wire which when connected in a circuit is best considered as an inductance, since inductance is a fundamental physical property of an alternating current circuit that depends essentially on the form of the conductor. The form in which this property asserts itself for consideration in electrical system and problems is known as reactance or more properly inductive reactance and produces an effect similar in some ways to a resistance, It resists the flow of current but does not consume energy. Resistance likewise resists current flow but consumes energy, this energy being converted into heat (I^2R) and lost. The energy applied to overcome inductive reactance is stored (as in a fly-wheel) through creation of a field effect and given back to the circuit as induced emf. The same inductance coil will have a different inductive reactance in circuits of different frequency since the rate at which the current changes determines its value. Thus it is that this property of a circuit—inductive reactance—is made use of in large central station systems to prevent rushes of current that would destroy generators and transformers by making the coils of such a design and placing them in such places as to choke back, so to speak, such rushes of current. These coils are usually mounted on concrete cores, the turns being properly supported and held in place.

The first statement of the question, it is to be inferred from the second, is a request for an explanation of what inductance (rather than reactance) is and what influence it has on the characteristics of alternating and direct current circuits. It must be remembered that every electric circuit possesses three distinct properties, namely, resistance, inductance and capacity, these properties being comparable to friction, inertia and elasticity in a mechanical circuit such as a pipe system conveying water under pressure or a head.

When an electric conductor carries a current, whether a direct or an alternating, a magnetic field is set up around the conductor. Any change of this current sets up a disturbance in this field requiring a definite expenditure of energy. The energy in the field of a conductor carrying a direct current will remain unchanged as long as the current is steady. In an alternating current circuit due to a continual change in intensity of the current flow, a corresponding simultaneous change occurs in the surrounding field. This change in intensity of the field reacts on the conductor and induces in it a counter emf of inductance which opposes any change of current. Thus it is that this counter-emf due to inductance impedes the variation and extinction of a current. In direct current circuits the effect is only noticed when a circuit is closed or opened.

In an alternating current circuit counter emfs are always present and whenever an emf is applied to a circuit, it has two functions to perform, namely, a part must overcome the resistance of a circuit and a second part must be used to overcome any counter emf set up. Thus

$E = E_1 + E_2$, where E_1 is the emf to overcome resistance (IR) and E_2 the emf to overcome counter-emf of inductance (IX). These values cannot be added as indicated but must be added vectorially or

$E = \sqrt{[(IR)^2 + (IX)^2]}$.

This is on account of the fact that the current in the resistance is in phase with the voltage while the current in the inductance is 90 degrees out of phase with the voltage.

In as much as we have said that there are three properties of any circuit, namely, resistance, inductance and capacity, it may be well to mention that the effect of capacity is opposite that of inductance and is known as capacity reactance. Thus the term for an alternating current circuit which corresponds to resistance of a direct current circuit is impedance (Z) and made up of ohmic resistance (R), inductive reactance (X_1) and capacity reactance (X_2), all measured in ohms. Thus,

$Z = \sqrt{[R^2 + (X_1 - X_2)^2]}$

The resistance of an A. C. circuit (R) as in a D. C. circuit depends upon the length and cross-sectional area of conductor. The inductive reactance varies directly as the inductance as already shown and the frequency of the circuit. The capacity reactance varies inversely as the product of frequency and capacity of the circuit.

W. E. White (N. Y.)

Reactance in an A. C. Circuit. Ans. Ques. No. 409.

Editor Electrical Engineering:

Reactance is a term used to express the effect of inductance or capacity in an alternating current circuit. Like resistance it is expressed in ohms. We know, however, that ohmic resistance itself is directly related to the current and voltage of the circuit. Now the reactance whether inductive or capacity reactance is a property of the circuit itself and depends entirely on its makeup. The reactance referred to in question No. 409 is inductive. This reactance is brought about by the effect of the magnetic field which is set up around a conductor carrying a current of electricity. A conductor of a given length and cross section, has greater reactance when wound in the form of a helix than when used as a straight conductor due to the action of one turn up the other. The reactance is still further increased by inserting iron in the helix.

In an A. C. circuit the current changes in value from zero to maximum four times every cycle. This means that the magnetic field surrounding a coil connected to an alternating current circuit changes at the same rate. The effect of this changing magnetic field as it cuts the conductors, is to produce an induced emf. Thus when the current is increasing in value, this induced emf tends to keep it from increasing and when the current is falling in value the induced emf tends to keep it from falling. This action in an alternating current circuit has the effect of keeping the current down or choking it back by making it lag behind the applied emf to such an extent that it does not reach the value it would on a direct current circuit. On a direct current circuit, the coil would have no effect other than to add its resistance to the circuit and its action would follow "Ohms Law" unless it was on a rapidly fluctuating voltage then its inductance would prevent the current from immediately assuming its full value when the circuit was closed, and would tend to prolong the current when the circuit was opened.

Power limiting reactances are used to limit excessive current rushes due to short circuits, surges or lightning developed in large electric generating systems. There are two kinds of reactances used for this purpose, the stationary or inductive and the rotary in which use is made of an induction generator. With some of the present large power systems it is evident that the momentary overload capacity must be enormous and should a short circuit concentrate this practically unlimited power at one point, the transformers or generators supplying this system would be subjected to mechanical strains created by the large magnetic fields due to this short circuit which would tear them to pieces.

No iron is used in the magnetic circuit or in any other part of the power reactance. Brass rods or other nonmagnetic metal is used for holding the different parts together. No iron is used in the magnetic circuit to prevent over saturation of the core at a time when it is most needed. To do so would necessitate working the iron at such a low density as to render the reactance too bulky and uneconomical in addition to its not being fully effective at times due to over-saturation of the iron. The design of the core varies with different manufacturers, some using a concrete cylinder with treated wood strips on which bare copper cable is wound.. Where the capacity of one cable is not sufficient, the required number are put on in parallel. Others use cores made of porcelain with insulated cables mica and fibre. Removable steel studs and eye bolts are provided for handling during construction and installation.

The location of these reactances depends entirely on local conditions and the size of the system. When used to protect transformers or generators from internal short circuits, they are inserted in the neutral lead. This does not prevent a large inrush of current from other generators or transformers which may be operating in parallel. While if they are placed in the phase leads no protection is afforded to the generator or transformer against internal short circuits but protect the system against short circuits as reduced by the reactances. So that it is apparent that the larger the system and the more units there are operating in parallel, it is better practice to have the reactances in the phase leads. Where the number of units is comparatively small, placing the reactances in the neutral would be better practice.

In the case of extremely large power generating systems, it is necessary in addition to reactances in the generators to have them placed between bus sections. In such a case they are of assistance to the switches which would be incapable of handling the large currents which would develop in case of a short circuit and the reactances not used. P. Justus (Ohio).

Action of Reactance in a Circuit. Ans. Ques. No. 409.

Editor Electrical Engineering:

To get a clear idea of reactance it is first necessary to understand the term inductance. Let us imagine a wire through which a direct current is flowing. Around this wire lines of magnetic force are created, and if the current is constant in value, these lines will be maintained without change. If now the current begins to decrease, the lines of force still tend to whirl or flow, so to speak, at the same rate and act as a flywheel, thus keeping the current from stopping instantaneously. On the other hand, when the current is increasing, the lines of force act as a flywheel which is being started, and oppose a change in current. This property of an electric current which makes itself felt through this effect, is known as inductance. Inductance is constant in value for any circuit, and is always much greater in a coil connected in the circuit than for a straight conductor.

In a direct current circuit where the current does not change continuously, inductance has but little effect. In an alternating current circuit, however, the effect is of importance, since the current is continually changing. Reactance is directly proportioned to inductance and frequency, and the formula expressing reactance is as follows:

$X = 2 \pi f L$, where X = reactance expressed in ohms; f = frequency expressed in cycles per second; and L = inductance expressed in henries.

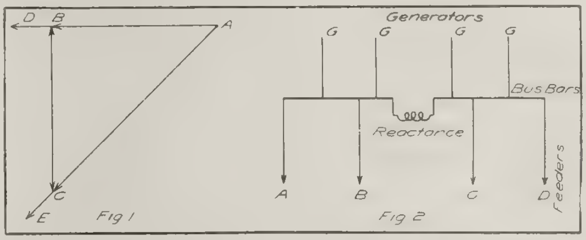


FIG. 1. DIAGRAM SHOWING RELATION OF INDUCTIVE REACTANCE TO RESISTANCE. FIG. 2. LOCATION OF SECTIONALIZING REACTANCE.

Let us imagine an alternating current circuit of fixed frequency in which there is a reactance of 10 ohms and no resistance. If a voltage of 100 volts were impressed, a current of 10 amperes would flow, but the power factor of the circuit would be zero, hence, the power of the circuit would be zero. If we now connect in the circuit a resistance of 10 ohms, then the total number of ohms or the total impedance of the circuit is $\sqrt{(10^2 + 10^2)} = 14.14$ ohms, and a current of $100 \div 14.14 = 7.07$ amperes would flow in the circuit.

Fig. 1 shows diagrammatically the relation of reactance to resistance. Let line AB represent the 10 ohms of resistance, and the line BC represent the 10 ohms of reactance. The total impedance of 14.14 ohms is then represented by the line AC. The current flowing in the circuit can be represented by the line AD and the voltage by line AE. The power factor is the ratio of AB to AC $= 10 \div 14.14 = 7.07$. Now, since power is voltage times current times power factor in a single-phase circuit, then the power in this system is $7.07 \times 100 \times .707 = 499.8$ watts.

As stated above, a reactance coil in a direct current circuit opposes any change in amount of current and has no effect when the current is constant in value.

Power limiting reactances are often used in high powered circuits where the current on short circuit would be apt to destroy generators and transformers. The amount of reactance in these coils varies and depends largely on the other reactance in the circuit. Transformers and generators always have some inherent reactance, and the idea is to have enough reactance in the circuit so that the voltage drop in this reactance will be 8 to 9 per cent of the total voltage when full load current is flowing. This will limit the current to about 12 times normal on short circuit. When the reactance of transformers, generators, etc., does not amount to this much, power reactances are installed to make up the difference.

The reactance is wound on a large concrete core and the layers of the winding are separated by strips of oil-soaked maple. All clamps and metal parts on the reactance other than the conductor, are of brass. These reactances are used in three general ways: (1) in series with generators; (2) in series with transformers; (3) to sectionalize bus bars. Fig. 2 shows the method of connecting in a sectionalizing reactance. In this case, feeders A and B should not be operated in parallel with feeders C and D, since they will be slightly out of phase. H. W. R. (Ga.)

Action of Reactance in a Circuit. Ans. Ques. No. 409.

Editor Electrical Engineering:

Properly speaking, the term "reactance" includes the effect of both inductance and capacity, but not of resistance, in a circuit. A reactance coil, however, has practically no capacity. A current flowing in a conductor produces a magnetic field around the conductor, and any change of current strength will change the strength of this field—or of the magnetic flux—around the conductor. If the conductor be wound in a coil, then the change of flux in any turn induces an electromotive force in adjacent turns, which will tend to send current in the opposite direction. The strength of this induced electromotive force depends upon the value of the current flowing, the rate of change of current, and upon the "inductance" of the coil itself. This later factor is a constant for a given coil, and depends upon the length, diameter and number of turns, in the coil. It is very greatly increased by the presence of an iron core, but iron is not used in central station reactances.

It will be seen that a reactance coil could produce an effect in a direct current circuit, only at the time the circuit is opened or closed, or when the current strength is changed. This is the reason a generator field switch is provided with a resistance for the discharge of the electromotive force of self-induction, which otherwise might rise to a sufficiently high value, when the field circuit is opened, to puncture insulation and short or ground the field winding.

Reactance coils for central station use are placed as close to the apparatus or lines they are to protect as possible. Their function is to limit or "choke" the current caused by a short circuit, thereby isolating the trouble to a certain extent. They may be placed between sections of a station bus, or on feeder circuits, or at the generator.

Reactance coils, or reactors, are usually of bare wire wound on cement, wood, tile or other insulating core, the whole apparatus, of course, being thoroughly insulated from ground. In the Standard Handbook (3d Edition), is given the following formula for determining number of turns:

$$N = 10\,E\,\sqrt{[X \div Ld \times f \times P]}$$

wherein E is the line voltage, x the per cent reactance (3 to 6 per cent of the reactance of the apparatus or line protected); Ld the mean diameter of the coil in inches (40 inches or more); f the frequency in cycles per second, and P the power rating of the generator (or feeder) in kilowatts. L. P. Brode (Cal.)

Spacing and Arrangement of Conductors for Transmission Lines. Ans. Ques. No. 412.

Editor Electrical Engineering:

The transmission wires in this problem, when located on the same cross arm, should be at two points so as to give the arrangement shown in Fig. 1. Each wire is then 18 inches from each of the other wires for 2/3 of the distance and is 36 inches from each of the others for 1/3 of the distance. The resistance and reactance of conductors for different spacings may be found from tables in any good electrical handbook. For this particular case the equivalent reactance of one wire is found by taking the reactance of one wire 18 inches from the return wire for 3 1/3 miles and adding to it the reactance of one wire 36 inches from the return for 1 2/3 miles.

Reactance of one 4-0 wire, 18 inches from return, per M feet = .1057 ohms.

Reactance of one 4-0 wire, 18 inches from return, for 3 1/3 miles = 1.86 ohms.

Reactance of one 4-0 wire, 36 inches from return, per M feet = .1216 ohms.

Reactance of one 4-0 wire, 36 inches from return, for 1 2/3 miles = 1.07 ohms.

The equivalent reactance for 5 miles = 1.86 + 1.07 = 2.93 ohms. The resistance of five miles of 4-0 wire = 1.32 ohms. When the circuit is delivering 750 Kva at 6600 volts between conductors at the load, the current per line wire is,

$I = 750{,}000 \div 1.732 \times 6600 = 65.6$ amperes.

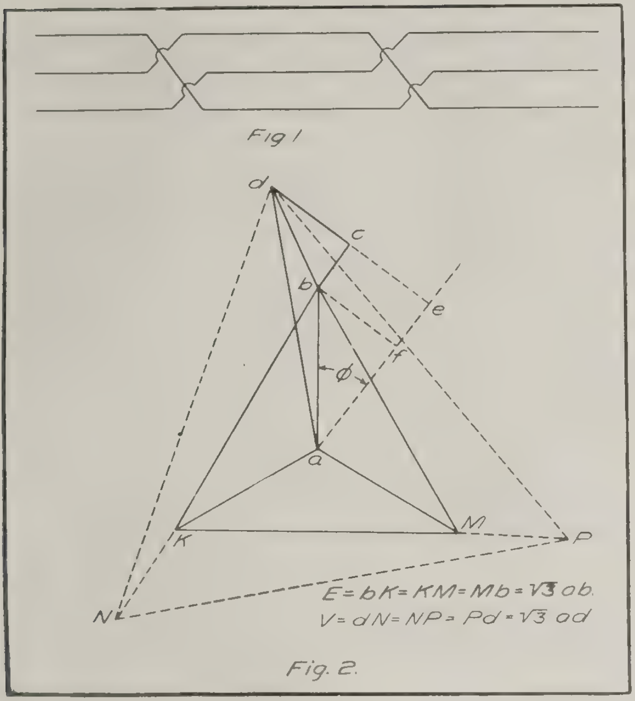
The resistance drop in each wire is $65.6 \times 1.32 = 86.6$ volts. The reactance drop in each wire is $65.6 \times 2.93 = 192.2$ volts. The impedance drop in each wire is $\sqrt{[(86.6)^2 + (192.2)^2]} = 210.6$ volts. This value of 210.6 volts would be indicated on a voltmeter if the meter were connected between the terminals of one of the line conductors. Owing to the fact that it is not in phase either with the voltage at the load or the voltage at the generator, a formula such as the following one must be used to find the generator voltage.

$$V = \sqrt{[(E \text{ cosine } \phi + \sqrt{3}\,IR)^2 + (E \text{ sine } \phi + \sqrt{3}\,IX)^2]},$$

where,

V = voltage at the generator, between wires; E = voltage at load = 6600; R = resistance of one wire in ohms; X = reactance of one wire in ohms; ϕ = the angle whose cosine is the power factor of the load. Taking a power factor of 100 per cent and substituting in the above formula, we find the voltage at the generator for conductors in a plane to be $V = \sqrt{[(6600 + 150)^2 + 333^2]} = 6758$ volts.

For conductors arranged in the form of a triangle 18 inches on a side, the reactance of one wire for five miles is 2.79 ohms. The resistance is 1.32 ohms and the impedance is 3.09 ohms. The voltage drop per wire is $3.09 \times 65.6 = 202.7$ volts The voltage at the generator is then,



FIGS. 1 AND 2. DIAGRAMS SHOWING TRANSPOSITION OF TRANSMISSION WIRES AND VOLTAGE CONSIDERATIONS.

$V = \sqrt{[(6600 + 150)^2 + 317^2]} = 6757$ volts.

If the conductors are arranged in a triangle 36 inches on a side the reactance is 3.2 ohms; the resistance is 1.32 ohms and the impedance is 3.46 ohms. The drop per wire is 227 volts and the generator voltage is,

$V = \sqrt{[(6600 + 150)^2 + 362^2]} = 6760$ volts.

If the load were such that the current of 65.6 amperes lagged behind the voltage by an angle of 30 degrees, the cosine of the angle or the power factor of the circuit would be .866 and the sine of the angle would be .500. When we substitute these values in the formula given above we find the generator voltages to be as follows:

For 18 inch spacing in same plane—6899 volts.
For 18 inch spacing in a triangle—6893 volts.
For 36 inch spacing in a triangle—6915 volts.

It would appear that the only choice for the arrangement of the wires in this problem would be based upon the practical question of installing in such a manner that there would be the least danger of short circuits.

The formula used for the calculation of the voltage drop in a three phase circuit, taking account of the resistance and of the reactance of the line wires may be derived as follows: Referring to Fig 2, *ab* is the voltage from an imaginary neutral to one terminal of the load and equals $E \div \sqrt{3}$; *ae* is the phase of the current in each wire and is behind *ab* by the angle ϕ; *bc* is the drop due to the resistance of one line wire, and is in phase with the current or with *ae; dc* is the drop due to the reactance of the line wire, and is 90 degrees ahead of the current in phase; $af = ab$ cosine ϕ, $fe = bc =$ IR drop, $fb = ec = ab$ sine ϕ, $dc =$ IX drop, $ad = \sqrt{[(af + fe)^2 + (ec + cd)^2]} = V \div \sqrt{3}$, being the voltage from the imaginary neutral at the load to one generator terminal. Hence $V \div \sqrt{3} = \sqrt{[(E \text{ cosine } \phi \div \sqrt{3} + IR)^2 + (E \text{ sine } \phi \div \sqrt{3} + IX)^2]}$, or if we multiply both members of this equation by $\sqrt{3}$, we have,

$V = \sqrt{[(E \text{ cosine } \phi + \sqrt{3}\, IR)^2 + (E \text{ sine } \phi + \sqrt{3}\, IX)^2]}$.

Prof. H. P. Wood, Georgia School of Technology.

Coughing in a Storage Battery Room. Ans. Ques. No. 422.

Editor Electrical Engineering:

In reply to the inquiry in Question 422 of the December issue, by E. J. Lopez, of Bangalor, Southern India, the writer offers the following:

When a lead sulphuric acid storage battery is charged, minute bubbles of hydrogen gas are given off from the negative plates, and minute bubbles of oxygen gas are given off from the positive plates. These bubbles, rising through the solution, escape through the tops of the cells as tiny balloons. These balloons, being composed of an envelope of sulphuric acid, with a light gas within, float increditable distances. When they finally strike against an object, these balloons burst and the sulphuric acid is deposited upon the object which causes them to burst.

When a lead sulphuric acid battery is being charged and the gases therefrom are inhaled by a person, these minute bubbles of gas burst in the lungs of the person. Naturally, sulphuric acid is not a very healthy thing to put into the throat and lungs. This irritation renders the tissue liable to infection from tuberculosis germs, pneumonia, etc. It is well known that the health of the men composing the crews of submarine boats is very much impaired by this sulphuric acid. A man cannot safely enter a submarine when the batteries are being charged, unless he is provided with some form of helmet. A great many of them do enter, and suffer as a result.

The Edison battery, composed of potash and water as the solution, is not subject to these disadvantages, for the following reasons: Although oxygen is given off from the positive pole and hydrogen from the negative, the minute bubbles of gas rising from the electrolyte must lift a valve in order to escape. In other words, they come into violent contact with a hard substance before leaving the cell. This breaks the bubbles and drains the potash back into the cell, allowing the oxygen and hydrogen gases to escape as free gases and not in the form of little balloons. It is well known that the breathing of oxygen and hydrogen is not detrimental to health. In fact, it is claimed by a great many people that it is beneficial. Peroxide of hydrogen, which is composed of water charged with hydrogen gas, is one of the most powerful disinfectants known. Therefore, instead of the lungs of people being injured by breathing gas emitted from Edison cells, the gas is beneficial. I have known of incidents where it has been claimed that testers of batteries, going into a testing room with a heavy cold, have had the cold entirely cured by breathing the gas from an Edison cell.

The best antidote I know of for an inflamed condition of the throat and lungs from breathing sulphuric acid vapor is a spray of some mild alkali. Doctors will prescribe this when they know the cause of the trouble. Naturally, the alkali, going into the lungs and throat, counteracts the acid, neutralizes the solution and gives off carbonic gas. However, unless the case is a very severe one, the ceasing of being associated with lead storage batteries and the patient taking lots of good exercise and fresh air, will give the lung tissues a chance to heal and overcome the trouble. There is always danger, of course, of infection through breathing air contaminated with tuberculosis germs, etc., and this oftentimes occurs before the tissue can be healed.

When the little bubbles of oxygen and hydrogen gas from the lead battery burst in the lungs, and the sulphuric acid is deposited on the lung lining, the presence of the oxygen tends to inflame the lining more, for the reason that oxygen should be kept away from membrane that is inflamed. That is the reason why, when you burn your finger, you put oil on it to keep the oxygen of the air away. Of course, there is oxygen in the air that a man breathes, but additional oxygen from the little bubbles irritates the membrane more than if he were simply breathing bubbles of hydrogen gas. ROBERT A. BACHMAN,

Edison Storage Battery Company.

Coughing in a Storage Battery Room. Ans. Ques. No. 422.

Editor Electrical Engineering:

Referring to the inquiry by your correspondent in India regarding tuberculosis caused by fumes from battery gases, I enclose copy of a letter which covers the situation fully.

A. N. Bentley.

"Replying to your letter of November 6th, I beg to say I have talked to Dr. Reed, our company physician, with regard to this matter and he confirms my own opinion, and that is, there is absolutely nothing poisonous in any way in the gases given off by a battery by charge, which could have any possible effect on a person suffering from tuberculosis.

"The only possible effect might be that a slight irritation of the throat and nose, with which we are all familiar when in a battery room, might bring on a fit of coughing which might cause some trouble, but as stated above, there is absolutely nothing which is poisonous. I might say in this connection that the very healthiest and huskiest men we have in our employ are those who are working constantly in the forming room where, as you know, the gases are very much thicker than in any outside battery room.

"We have never known of a case of tuberculosis being caused by such work and in the opinion of many doctors it is beneficial rather than otherwise."

C. Hodge, The Electric Storage Battery Company.

New Apparatus and Appliances

Rico Coasting Time Recorder.

An instrument that records the actual number of minutes that an electric car or train is operated without the use of power or brakes has recently been devised. This device provides an accurate and consistent means of obtaining a record of the amount of coasting secured in the operation of electric railway equipments. It thus provides a means for inducing motormen to use the energy input to a car to overcome the resistor losses in starting, to overcome the losses in the motors and wiring, to impart velocity to the car, and to overcome friction. It has long been admitted that a large part of the total electrical energy is wasted daily on nearly every railroad in the country through the variable handling of cars by motormen, and it is remarkable that this great loss has continued for years without steps having been taken to correct it.

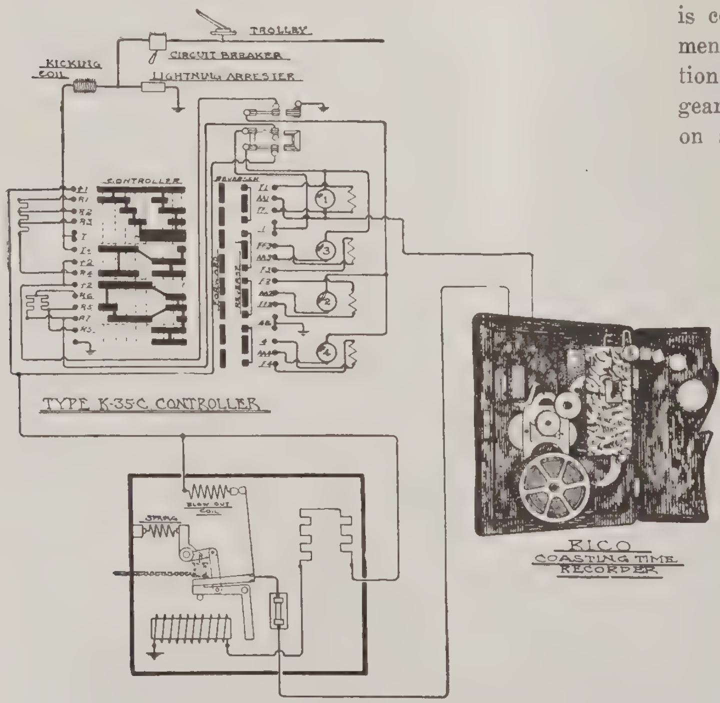


FIG. 1. WIRING DIAGRAM OF COASTING RECORDER.

The device mentioned is known as the Rico Coasting Time Recorder and has proven in service that it effectually eliminates most of this loss. It is a simple and reliable automatic device which effectively puts an automatic and impartial check upon each man at all times. It records in coasting minutes, and its object and method of operation are readily understood by the motorman, who soon becomes not only alert in its use but enthusiastic in the support of operation which is increasing his efficiency and actually his earning power.

The coasting recorder consists of a recording mechanism as shown in Fig. 1 and an electric relay. One recorder and one relay are necessary for each car or each multiple-unit train. The recording mechanism consists of a specially-designed recording instrument somewhat similar to those in use for factory time keeping. The printing mechanism is controlled and driven by a double-spring marine-movement clock, especially designed to withstand excessive vibration and climate changes. This clock movement is directly geared to the recording mechanism and both are mounted on a solid cast-steel frame and enclosed in a steel case.

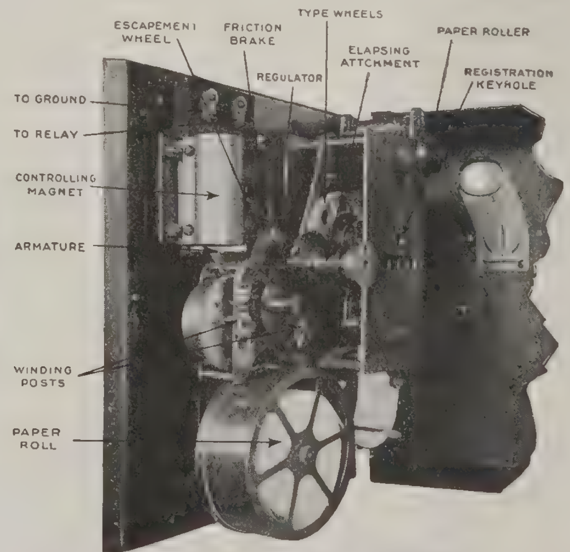


FIG. 2. THE RICO COASTING RECORDER.

Each motorman is given a registration key, bearing his badge number. With this key he registers at the beginning and end of the trip.

An examination of the wiring diagram, Fig. 2, shows that the current can reach the controlling magnet on the clock movement only when the traction motors are running as generators; the back e.m.f. or generated voltage of the motors when coasting furnishes energy for the clock magnet. The magnet and brake attachment is so arranged that it can be adjusted to meet any operating condition. The electric relay is so arranged that when the controller is "on" no current can possibly get through to the clock magnet from the traction motors. When the brakes are applied the clock circuit is opened. Consequently a motorman must have the car moving without power or brakes on in order to get the current into the magnet that operates the clock. With this type of relay it is impossible for a motorman to "coast to a standstill" and obtain a fictitious record, as the energy which operates the clock magnet ceases when the motor stops.

These instruments are being marketed by the Westinghouse Electric & Manufacturing Company for use with equipment of its manufacture.

Battery Charging Panels.

Owing to the steady increase in the use of electric passenger and commercial vehicles, charging stations are called upon at frequent intervals to increase the capacity of the charging equipment. Because of this, it is advantageous to install equipment to which additions can be made easily and economically. A new universal unit type of charging panel has been designed by The Cutler-Hammer Mfg. Company, of Milwaukee, and made up of self-contained rheostats assembled in frames in much the same way that the present day sectional filing cabinets or book cases are assembled, each standard panel accomodating any number of sections up to six. Any number of panels can be assembled side by side according to the space available and regardless of the fact that these may be installed at different times, will have the appearance of a complete equipment installed at one time.

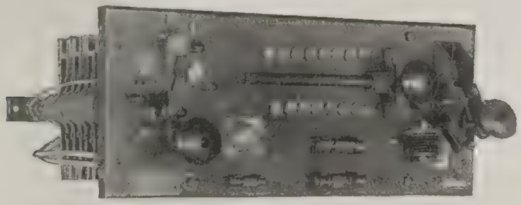


FIG. 1. SINGLE UNIT OF CUTLER-HAMMER BATTERY CHARGING PANEL.

Each charging section is a unit in itself as shown in Fig. 1. It consists of a slate front 24 inches by 10 inches, carrying the rheostat contacts and sliding brush; a low current circuit-breaker, at left side; an instrument switch, at right; a pilot lamp and grid type resistance mounted on the back. Each section is supported by bolts to the frame and after disconnecting from the bus-bar can be readily removed if these bolts are taken out.

The low-current circuit-breaker mounted at the left of the front has a laminated brush main contact and auxiliary arcing points. It is interlocked with the rheostat so that it cannot be closed except when the sliding brush is moved to the position of "all resistance in." It can then be closed and a small magnet, which is in series with the charging circuit, holds it in this position unless the charging voltage falls to a value less than the battery voltage, or in case the service fuses should be blown. It acts as a line switch.

The instrument switch is a three-position switch having "open," "closed" and "reading" positions. When in the "open" position the circuit to the battery is broken; moving to the "closed" position completes this circuit, and when in the "reading" position the meter, which may be mounted on the top section or on a swinging bracket, is connected in the battery circuit indicating the voltage of the battery. If the low-current circuit-breaker is closed, the current is also indicated on the ammeter scale of the instrument.

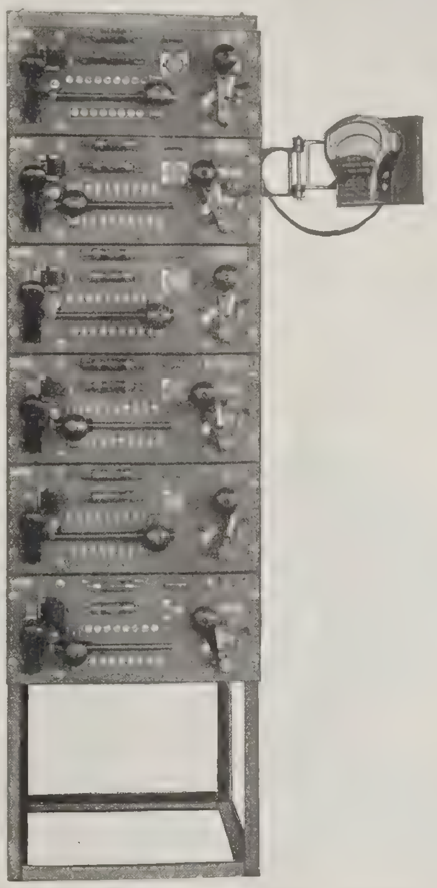


FIG. 2. ASSEMBLED UNITS OF BATTERY CHARGING PANEL.

The duplex instrument which is furnished combines ammeter and volt-meter, and a single instrument can be used for several panels if desired. The scales are five inches long and thus allow very close readings.

The Ralco Heavy Duty Plugs and Receptacles.

A new line of heavy duty plugs and receptacles has been produced by the Central Electric Company, 320-326 South Fifth Avenue, Chicago, Ill. The nature of the Ralco plug and receptacle designed for 30 amperes is shown in

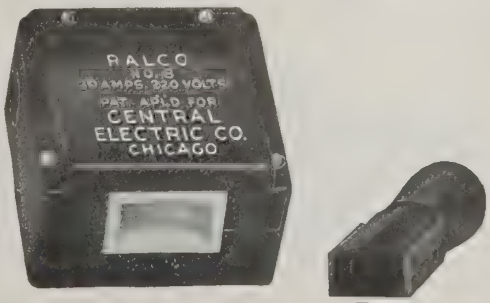


FIG. 1. RALCO NO. 8 PLUG AND RECEPTACLE.

the accompanying illustration and is known as No. 8. Other designs provide for 60 and 100 amperes and are known as Nos. 9 and 14. These plugs and receptacles are especially applicable for the connection of current consuming devices to supply circuits, such as washing machines, vacuum cleaners, irons, heaters, etc., and in industrial establishments for the correction of electric welding apparatus, portable grinders, riveters, boring tools, forges, small motor driven latehes, etc.

These devices are now essential in order that current consuming apparatus may give reliable and safe service and where power circuits are run for the operation of the apparatus mentioned, such plugs and receptacles as the Ralco are important considerations.

The Bell Compensated Polyphase Motor.

A new type of polyphase motor has been developed by the Bell Electric Motor Company, of Garwood, N. J., that is claimed to be a strong competitor of the squirrel-cage motor, due to the fact that it is of rugged design and can be thrown directly on the line at starting in large sizes, up to 40 horsepower, without the use of a starting device or external resistance.

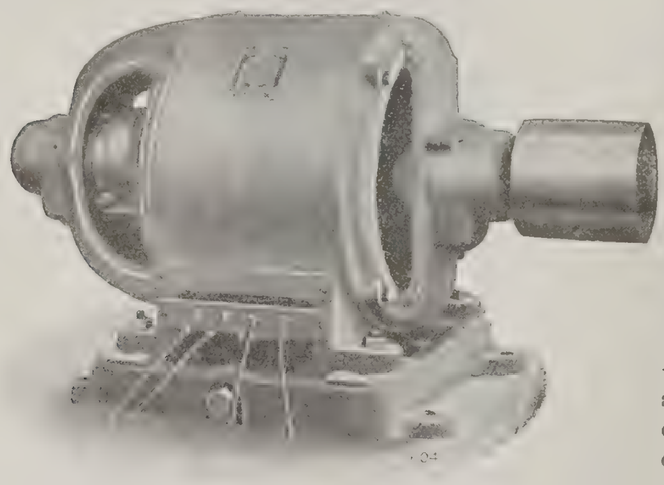


FIG. 1. THE BELL COMPENSATED POLYPHASE MOTOR.

The principle upon which this motor operates is that of a high resistance squirrel-cage winding, with which the motor is brought up to speed. Under this squirrel-cage winding is an extra high resistance coil winding, with coil terminals connected to a commutator, which is short-circuited when full speed is about attained. The rotor then operates with low internal resistance, high efficiency and small slip. By means of the two independent windings upon the rotor, a double transformation takes place, which reacts upon the stator windings, thereby raising considerably the power factor of the motor itself. At starting the power factor of these motors ranges from 80 to 85 per cent, and are said to cause less line disturbance than the ordinary squirrel-cage motor. The starting current varies from two to two and one-half times full load running current. These motors are said to start satisfactorily under full load and where extra static friction has to be overcome at starting, an increased torque can be obtained by short-circuiting one or more of the commutator bars, with the small bridges provided on the commutator.

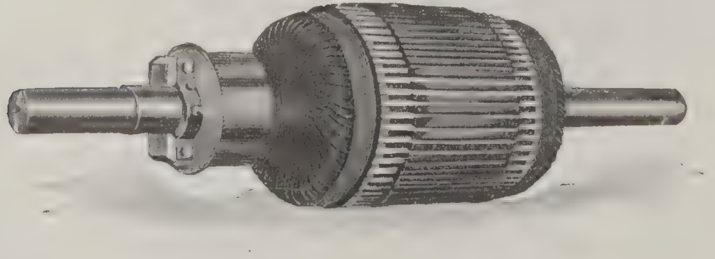
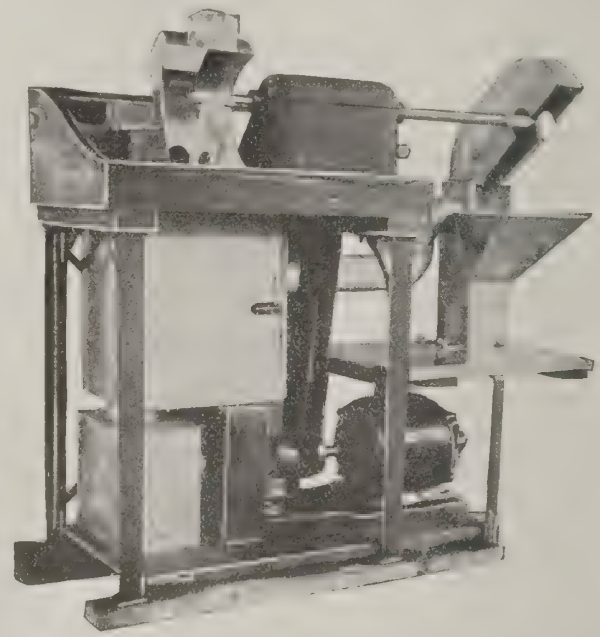


FIG. 2. COMPENSATED ROTOR OF BELL POLYPHASE MOTOR.

Dust Removing Apparatus.

Health and factory authorities are devoting considerable attention to a means for removing dust while polishing metals. The accompanying illustration shows a device for sucking this dirt away as designed by Leiman Brothers, 62 John Street, New York City. The apparatus consists of a blower or suction machine located directly under the bench on which polishing is done, and in such a position as to create a powerful suction directly at the buffers. A constant stream of air thus draws in the particles of dust and deposits same in a tank, as shown, where it can be removed as desired.

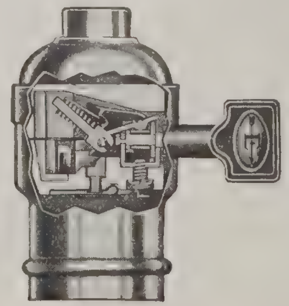


APPARATUS FOR REMOVING DUST WHEN POLISHING METAL.

The suction device shown will accommodate buffers as large as 8 inches in diameter and 2 inches wide. One and a half horsepower motors are usually used, yet with smaller outfits smaller motors can be used as low as one-third Hp.

A New 660-Watt Socket.

A new 660-watt key socket with quarter-turn quick-make-and-break-mechanism has been produced by the Arrow Electric Company, Hartford, Conn. The accompanying illustration shows a sectional view of the socket and the mechanism. It is designed to break three amperes on 250 volts and is claimed to safely carry 50 per cent overload.



A NEW ARROW KEY SOCKET OF 660 WATTS.

The rapid development of current-consuming devices has brought about the need of a socket with a greater capacity than the ordinary key socket, and it is to meet this need that the new socket has been designed. This socket is interchangeable with the company's standard key sockets, in both "arrow forty" and "arrow twenty" types, and is listed in the company's new catalog under the standard catalog numbers, with the letter "W" added.

Semi-Indirect Lighting Units.

With the comparative recent gradual raising of the standard of illumination, the general tendency of the designer of lighting accessories, has been to direct his energy toward the production of lighting equipment of an increased efficiency, with the result that artistic considerations have not been given the thought, which they justly deserve. To no one thing more than this is due the hesitancy of the architect to co-operate with the illuminating engineer, for he is, from the point of initial cost, limited to a certain extent, to the use of equipment obtainable.

However, at the present time, since a hitherto unthought of efficiency in both the light source itself and the accessories, or glassware, has already been reached, more attention is being paid by the designer and manufacturer of lighting accessories, to the question of beauty and harmony of design.

The increased brilliancy of the incandescent light sources of recent development and the public's gradual awakening to the value of its eyesight and the detrimental effects of glaring light sources, thereto, has perhaps been largely responsible for the public's willingness to sacrifice to a certain extent efficiency, for concealed light sources and the consequent elimination of glare. This general tendency in turn has been a big stimulant to the design of semi-indirect lighting fixtures.

A SEMI-INDIRECT GLASS BOWL OF RENAISSANCE DESIGN MADE IN LUCIDA GLASS.

Semi-indirect units may be grouped into two general classes. First, those in which the diffusing medium, a generally shallow glass bowl of plain or art glass design is held in a metal frame work and second, those in which the diffusing bowl or placque of more or less elaborate design is supported by hangings attached directly to the periphery of the bowl. There is practically no limit to the possibilities of practical designs in these types of fixtures and especially in the last mentioned type, where in fact, the limit depends entirely on the glass manufacturer's willingness to provide the costly molds, which are required for making the bowls. Here again, the glass manufacturer has not shirked his obligation in contributing to better and more artistic lighting effects

Numerous shapes and sizes of semi-indirect bowls and placques are now obtainable in designs, characteristic of different historic periods and different types of architecture, so that the illuminating engineer is enabled to collaborate with the architect in designing efficient and artistic lighting effects, which harmonize with the particular type architecture of the interior.

The accompanying illustration shows the side and bottom view of a "Renaissance Design," shallow semi-indirect bowl, in Lucida Glass, made by Hoskins Glass Company, which is characteristic of this class of semi-indirect lighting units and demonstrates to what extent it is possible to carry the elaborateness of design and also shows the distinctive features in art design of the historic period of the "Revival of Learning" in the 15th and 16th centuries.

The Elevator as a Central Station Load Builder.

In the distribution and movement of the congested population of a great city, especially in its business centers, vertical transportation now plays a most important part. Not only has the elevator made possible the skyscraper, but it is no less essential to the office, department store, warehouse, loft, and apartment building of more modest height. As an example of the growth of elevator traffic, it has been estimated that the daily elevator traffic in the large cities outnumbers that of the traction companies nearly two to one, and while this work is widely distributed, yet the volume of traffic, if not the actual mileage, makes a most interesting transportation problem, which parallels that of the ordinary railway.

From the standpoint of the central station, however, the elevator is equal in importance to the railway, for while the latter derives power from its generating plant, the former usually derives current from the central station also, and i sclassed as a steady current consumer—an ideal consumer in the fact, operating chiefly during daylight hours. On this account in the last few years the number of electric elevator installations has increased surprisingly, as has also the economy and efficiency of operation of the electric elevator machine. The aggregate consumption assumes large proportions when we consider the large number of electric elevators already installed as well as the almost unlimited field for future growth.

Of equal importance to the central station aside from the big possibilities for new business afforded by the electric elevator is the vast saving brought about by the vertical building growth made possible by the electric elevator.

Cities can expand in only two directions, horizontally and vertically. The elevator by enabling cities to grow upward has been the means of saving the central station millions of dollars investment in underground plant, which would have been necessary in case of horizontal growth, to secure the same business enjoyed today.

So much for the vertical elevator. There is another type of motor driven elevator known as the inclined elevator, which is being installed in factories of every type and description where, in the course of manufacture or shipment, the product must be moved from department to department, or from floor to floor. This type of elevator, because of its economical and efficient handling of constantly increasing output, due to its continuity of motion—it is a continuous carrier in the form of an endless moving chain—bids fair to ultimately find a place in every factory. The inclined elevator is also being used at docks to load and unload ships, and in department stores to move packages from the shipping room in the basement to the sidewalk, ready for delivery. There are several types of these elevators covring a wide range of applications, which makes it possible for it to meet every condition of internal traffic service.

The escalator also, which operates on the same principle as the motor driven inclined elevator, but which is used for carrying passengers instead of freight, is another type of elevator which is fast gaining ground for use in public buildings. The escalator is being used in department stores, at elevated railway stations, railway terminals, theaters, amusement parks, and hotels for handling the passenger traffic. Installations have also been made in factories to move employes at morning, noon and evening.

The possibilities for new power business through the installation of the above types of electric elevators merit the efforts of the central station new business man. With proper activity combined with the educational and development work now being done to increase the use of electricity for domestic and industrial purposes, the elevator field is sure to be given the importance it deserves and make an important load builder.

A New Trolley Harp.

A new device known as the "M-B" trolley harp, has been placed on the market by the Western Electric Company. The harp proper is made in two parts with two steel wheel bearings set in a recess and held in place by steel dowel pins. Both halves of the harp are provided with chambers for holding the lubricating device, which consists of a wool yarn packing or oil wick saturated with heavy motor oil. To insure thorough lubrication, a slot is cut in the steel bearings so that the wheel spindle may come in contact with the oil wick. The chambers have sufficient capacity to hold a week's supply of lubricant. To replenish the oil supply, it is only necessary to press the point of the oil can against the spring checks located on the top part of the harp.

The trolley wheel is equipped with a bronze axle. This axle is sweated into the hub, which takes the place of the old graphite bushing. The combination of the bronze spindle or axle and the steel bearings is calculated to lengthen the life of the wheel to a considerable extent. Another feature of the design is found in the fact that the tension of the trolley base keeps the wheel spindle resting on the bottom of the steel bearings. This has been found to aid greatly in reducing vibration to a minimum and in increasing the conductivity. Furthermore, current is not conducted through the spindle or bearings, but is collected by strong bronze contact springs.

Electrical Construction News

This department is maintained for the contractor, dealer, manufacturer and consulting engineer.

FLORIDA.

OCALA. Itis understood that J. B. Robertson proposes to construct a hydro-electric plant at Stokes Ferry on the Wichlacooche River.

WINTER GARDEN. The Winter Garden Light & Water Company is constructing a three-phase transmission line 2½ miles long to connect with Ocoee. M. L. Calvin is treasurer.

ZOLFO. It is understood that the installation of a lighting system is to be investigated. The matter is being taken up with the Wauchula Mfg. Co., to supply energy for this service.

GEORGIA.

AMERICUS. The Americus Gas & Electric Co. is to rebuild and consolidate its transmission line and those of the American Power Co. W. M. Chase is general manager.

GLENVILLE. The city has voted to construct an electric light plant.

GRIFFIN. The Towaliga Falls Power Co. plans to purchase a 1400 Kw. generator and 1800 Hp. water wheel with auxiliary equipment.

LAWRENCEVILLE. J. B. McCrary & Co., of Atlanta, is to construct a hydro-electric plant at Anderson, Ga., and erect a transmission line 30 miles long passing through Loganville, Grayson and Smellville.

McDONOUGH. It is understood that an extension to the distribution system is to be made in McDonough and a new street lighting system installed. Some 44 series tungsten lamps will be used.

VALDOSTA. The Valdosta Lighting Co. expects to construct several miles of transmission lines in the early future. W. G. Eager is vice-president.

NORTH CAROLINA.

CHARLOTTE. The Charlotte Electric Railway will install a 750 Kw., 600-volt, direct current, 6-phase, 60-cycle rotary converter, and three 275 Kva., single-phase, 60-cycle, 2200-volt transformers, as well as switchboards and control apparatus.

CLINTON. The Samson Power Co., of Clinton, is to purchase engines, generators and auxiliaries as well as transformers, poles, meters and lamps for the new station.

GREENVILLE. The city is to install a 500 Kw. steam turbine and generator with exciter and condenser. Boilers will also be purchased and a pump of 1,000 gallons per minute to be motor driven.

NEWBERN. The city will soon complete its power station and purchase and install a 500 Kw., 2300-volt, three-phase steam generating unit. A number of arc lamps will also be installed.

OLD FORT. It is reported that the White Coal Power Co. is contemplating the construction of a hydro-electric plant on the Catawba River. D. W. Adams, of Asheville, is chief engineer.

SCOTLAND NECK. The city expects to make an addition to its power house and purchase boiler and engine and generator of 200 Kw. capacity with auxiliaries. L. R. Mills, Jr., is superintendent.

STATESVILLE. The city light and power department is to erect a two mile transmission line to operate at 2300 volts. J. B. Cochrane is superintendent.

KENTUCKY.

LOUISVILLE. The Louisville Gas & Electric Co. has employed the H. M. Byllesby & Co., of Chicago, as consulting engineers and supervisors for the installation of eight 500 Hp boilers, two 5,000 Kw. turbines and coal handling machinery.

PIKEVILLE. The Sand Valley Light & Power Co. contemplates the changing of its entire plant from 220-volt direct-current to 110-volt, 60-cycle, alternating current. About 250 meters will be purchased and series tungsten street lighting outfit.

MISSISSIPPI.

GRENADA. The city expects to purchase within the next few months a number of light standards for five lamp cluster ornamental street lighting. J. W. Lowery is superintendent.

WEST VIRGINIA.

FAIRMOUNT. It is reported that the Fairmount & Clarksburg Power Co. plans to construct two plants, No. 1 at Valley Falls, 14 miles from Fairmont, and No. 2, six miles south of Grafton. No. 1 plant will develop 10,000 Hp. and No. 2 50,000 Hp. Approximate cost of developments will be $280,000.

PERSONALS.

MR. E. B. ROWE, chief illuminating engineer of the Holophane Works of General Electric Co., Cleveland, presented a paper on lighting topics before the members of the Cornell A. I. E. E. section at their regular December meeting at Ithaca, N. Y., on the 12th. The subject being—"The Influence of Science on the Art of illumination."

MR. J. G. WHITE arrived in New York December 10, on the Olympic after six months absence in England and the Continent. Much of his time was spent in London at the home office of J. G. White & Company, Limited, of which he is president. One of the important recent financial undertakings of that company is the formation of the International Light and Power Company, Limited, a holding company owning securities in several Electric Light and Tramway properties throughout South America.

MR. H. W. YOUNG, president Delta-Star Electric Company, Chicago, addressed the Illinois Northern Utilities Branch of the N. E. L. A., Dixon Ills., at their meeting Nov. 21st, the subject being, "Selling PowerFrom High Tension Lines." Some 40 lantern slides were shown of modern outdoor high tension installations.

G. M. GEST, engineer and contractor, 277 Broadway, New York City, announces that executive offices were moved on December 1st, to suite 1320-36 Woolworth Bldg., New York City.

MR. J. E. LATTA, who for some time has been an associate editor of the Electrical Review and Western Electrician, resigned on December 1 to join the staff of the Underwriters' Laboratories of Chicago. Mr. Latta is a native of North Carolina and a graduate of the University of North Carolina and of the Graduate School of Harvard University. He studied engineering for a time at the Polytechnic Institute of Brooklyn, N. Y., at Stevens Institute of Technology, Hoboken, N. J., and in the shops of the Westinghouse Electric & Manufacturing Company, and Hooven, Owens, Rentschler Company, Hamilton, Ohio. He was elected general manager of the Durham (N. C.) Traction Company in 1903, but declined this position in order to become assistant professor of physics in the University of North Carolina. He was acting head of the department of physics and applied electricity for a year and a half, when he was appointed professor of electrical engineering. He stayed here until 1909, in the meantime being engaged as a supervising and consulting electrical engineer in various parts of the country. He entered the employ of the General Electric Company at Harrison, N. J., in 1909, where for seven months he had charge of the course in applied electricity and illuminating engineering, conducted by the company for its employes. He then took up electric power-plant construction and operation in the Southwest until the summer of 1911, when he became technical editor of Electrocraft, then published at Detroit. With the purchase of the latter publication by the Electrical Review and Western Electrician, Mr. Latta became an associate editor on the staff of this publication, devoting his attention mainly to electrical contracting and electrical inspection.

MR. L. M. WOOD, who for the past seven years has held the position of purchasing agent for the Wesco Supply Company, of St. Louis, Mo., has resigned to accept the position of sales manager with the Menominee Electric Mfg.Co., of Menominee, Michigan. This company manufactures a complete line of fans, vacuum cleaners and small motors. Mr. Wood took up his new work on January 1st and carries with him the good wishes of a host of warm friends in the South and Central West.

MR. L. S. MONTGOMERY, formerly Southern sales manager of the National Metal Molding and now in charge of an important middle west district, has recently spent several days in Atlanta visiting friends. Mr. Montgomery is very optimistic in his statements in regard to present business conditions and believes that the coming year can be approached with considerable confidence in regard to electrical business.

Industrial Items.

ALFRED F. MOORE, Philadelphia, Pa., advises that Mr. E. P. Bartlett will represent the company in Chicago at 1368 Grand Ave. A complete stock of wire is carried at this point.

THE R. S. MUELLER AND CO., of 423-25 High Ave., S. E., Cleveland, Ohio, has designed and is now offering a test clip that will carry 100 amperes. When applied to flat surfaces where the jaws make good contact, it is claimed to carry 200 amperes without excessive heating.

THE SPRAGUE ELECTRIC WORKS of General Electric Company, in bulletin No. 247, describes a so-called round type D. C. motor. Details of design and construction together with illustrations showing applications are presented.

THE H. W. JOHNS-MANVILLE CO., of New York City, announces that the Toronto branch has moved to more spacious quarters at No. 19 Front Street, East. This new store and warehouse has a floor area of approximately 35,000 sq. ft. and is situated in the heart of the wholesale district. A larger stock will be carried and ample space provided for the display of a complete line of asbestos roofing, packings, pipe coverings, building materials, electrical and railroad supplies, automobile and plumbing specialties. The entire building will be lighted by well-known Frink and J-M linolite system of lighting and one room will be used for exhibiting these systems of lighting.

W. R. HAYNE, as American representative of Usines Carels Freres, 30 Church street, New York City., reports the sale of a 750 Hp. Carels-Diesel engine to be direct connected to a 500-Kw., 60-cycle, 3-phase Westinghouse generator, and installed by the Coronet Phosphate Co., in Florida.

THE PYRENE MFG. CO. has issued a very attractive folder reproducing a number of advertisements of Pyrene fire extinguishers and testimonials describing their successful use. This company announces also a reduction in insurance rates on all pleasure cars and commercial cars by the Aetna Accident and Liability Co., and the Automobile Insurance Co., of Hartford, Conn., when cars are properly equipped with approved Pyrene fire extinguishers of one quart capacity.

THE NATIONAL LAMP WORKS of General Electric Co., has recently published a comprehensive bulletin No. 20, on industrial lighting,which deals with the different factors that must be given consideration in the design and operation of an industrial lighting installation. The effects of voltage conditions on the operation of lighting units are clearly explained and curves given showing the performance of incandescent lamps in actual practice. Different types of reflectors are discussed at length along with their distribution curves. The effect of accumulation of dust on reflectors of different types is illustrated graphically. The principles of illumination design and the methods of figuring operating cost are also clearly outlined. The application of modern methods of illuminating engineering is shown by a number of illustrated installations with complete data on each. Copies may be secured by addressing the Engineering Department, National Lamp Works of General Electric Co..

THE KIMBLE ELECTRIC COMPANY, Chicago, makers of variable speed, alternating current motors, have just moved into a new plant at Erie street and Western avenue. This plant will give them three times the available working space that they had in their old plant at Washington Boulevard and May street and will have perhaps six times the producing capacity because of the efficient and economical sequence of machines and processes all on one floor as contrasted with the inconvenient arrangement of the old two-story factory.

The rise and growth of the Kimble Electric Company has been rapid. In 1904 Austin Kimble started to build his first motor in an improvised shop in a barn and his only power was a second-hand automobile engine. In about a year from that time he moved to a small machine shop on Lake street. A year later his business increased to such an extent that he rented the second story of a machine shop at Adams and Paulina streets, and in another year from that time the business was transformed into a stock company and moved to 1121 Washington Boulevard, where it occupied one floor. The business grew and soon the demand required an extension and the second floor was rented in the same building. In the new building the office occupies the second floor in the front of the building on the Western avenue side.

THE BELL ELECTRIC MOTOR CO., of Garwood, N. J., announce the construction of two modern fireproof factories, steel and concrete construction, about 200 feet long, to be used in addition with their present factory buildings.. These buildings are expected to be completed in about three months' time, and will be up-to-date in every respect. Special attention has been given securing perfect daylight by means of glass windows running the entire length of the factory. Also special attention has been given to the installation of up-to-date apparatus by means of which they will be enabled to generate single-phase, two-phase and three-phase current of all commercial voltages. An extra railroad siding is being run to connect these factories together with their other factory buildings. They announce that the sale of Bell single-phase motors has doubled during the last year.

THE NORFOLK AND WESTERN RAILROAD, which extends from the tidewater at Norfolk, Va., to the coal fields of West Virginia, has contracted with the Westinghouse Electric & Manufacturing Company to supply all the electrical apparatus required to electrify the Bluefield-Vivan section of its line some 85 miles in length. The carrying out of this contract will give form to one of the most important projects of steam railroad electrification yet undertaken. The contract calls for the manufacture and delivery of twenty-six 130-ton electric locomotives of the single phase-two phase type, together with all required power house generating machinery and transmission apparatus. Single phase alternating current of a frequency of 25 cycles and at 11,000 volts pressure will be supplied to the locomotives through an overhead suspended trolley wire and will be the identical type of the overhead system that has long been successfully used by the New York, New Haven and Hartford Railroad on its main line, by the Boston and Maine in the Hoosac Tunnel, by the the Westinghouse Electric & Manufacturing Company has fur- Grand Trunk Railway in the Sarnia Tunnel and by the New York, Westchester and Boston Railway and for which installations nished over 100 locomotives.

Trade Literature.

CATECHISM ON ALTERNATING CURRENT APPARATUS. As a companion book to "Catechism on Direct Current Apparatus," Fairbanks, Morse & Company, of Chicago, have recently issued a Catechism on Alternating Current Apparatus. It is a booklet dealing with the construction and application of generators, motors and auxiliary equipment, in which the writer has succeeded in giving in a condensed question and answer form a very great amount of practical information. From a short description of how alternating current is produced, arguments are given not only on general points of construction and operating characteristics of A.C. equipment, but also on such points as: Advantages of alternating current, advantages of direct current, choice of A.C. or D.C., electrical characteristics that must be considered in comparing alternators, advantages and limitations of synchronous motors and split phase motors, etc., etc. Copies will be sent to interested parties on request to the Chicago office of the company.

CONSTRUCTION APPLIANCES. Catalogue No. 12, issued by the Brady Electric and Mfg. Co., of New Britian, Conn., describes and illustrates, mast arms, pole arms, cutouts, brackets and reflectors for street arc and incandescent lighting.

ELECTRIC MOTORS. The Holtzer-Cabot Electric Co, of Boston and Chicago, has issued an attractive bulletin devoted to electricity in the manufacture of jewelry. The catalogue shows numerous uses of small motors.

ELECTRICAL SPECIALTIES. Machen and Mayer Electrical Mfg. Co., of 21st and Fairmount Ave., Philadelphia, Pa., has issued catalog 6, taking up switches, receptacles, switch boxes, heater receptacles, panel boards and accessories. Illustrations, descriptions, wiring diagrams and price data are included.

SMALL MOTORS. Points of Importance in Selecting and Applying Small Motors, is the title of descriptive leaflet 2441-A just issued by the Westinghouse Electric & Manufacturing Company which covers in a brief and concise manner the various items entering into the selection and application of small motors for use on either alternating or direct current circuits. These instructions cover the operating characteristics of both A. C. and D. C. motors, and in case of the latter, both shunt and compound wound. Instructions are also given as to mounting and method of drive.

STEAM TURBINES. Low pressure steam turbines manufactured by the Westinghouse Electric & Mfg. Company are described and illustrated in descriptive leaflet 2485 just issued by that company. This publication applies more particularly to the application and operation of turbines in connection with other steam-driven units rather than the construction of the turbines. An interesting diagram is shown illustrating the mechanical connection of the non-condensing engine, synchronous motor and the low pressure steam turbine.

TEXTILE QUARTERLY. No. 2 of the textile quarterly issued by the Westinghouse Electric & Mfg. Company is devoted to motor drive in worsted and woolen mills. A number of installations are shown, together with detail views of the Westinghouse textile motor. The Quarterly treats the various methods of drive and installations, and will undoubtedly prove of great interest to those interested in this form of motor application.

FARM MOTOR DRIVES. Westinghouse Motors is the title of an attractively gotten up little folder, 4231, issued by the Westinghouse Electric & Mfg. Company covering the application of Westinghouse motors to the various classes of machinery. The frontispiece shows the Westinghouse 5 horsepower motor in use on a farm, driving a corn-sheller, feed-cutter and other apparatus used on the farm. Other applications are woodworking shops, machine shops, printing presses, etc.

A. C. WATTHOUR METERS. The Westinghouse Electric & Mfg. Co. has just issued folder 4241 covering A. C. Watthour Meters. This publication describes and illustrates the well-known type C Meter, and the later developed OA. Curves illustrating the performance of these meters are also given.

IGNITION SYSTEMS. Westinghouse Electric Ignition and Lighting Systems, is the title of a very handsome catalog just issued by the Westinghouse Electric & Mfg. Company describing and illustrating in detail the new ignition and lighting system for gasoline automobiles recently placed on the market by this company. The book has an attractive art cover and is printed by the off-set process. Complete detail views, together with diagrams are given of the apparatus as well as a thorough description of the methods of construction of same. In addition to the ignition and lighting sets, a number of other automobile accessories which are manufactured by the company are described, such as the vibrating rectifier, automobile tire vulcanizer, and wiring details used in connection with the ignition set. This publication No. 1203 will undoubtedly prove very popular among those interested in automobiles.

THE DIEHL MANUFACTURING CO., of Elizabethport, N. J. has recently distributed bulletin 505 describing electric absorption dynamometers. Various applications are taken up, including carbureter, chassis, gear transmission, centrifugal pumps and blower tests. Illustrations of the equipment are shown.

THE ALLIS CHALMERS COMPANY has issued bulletin 1631 discussing hydraulic turbines known as Types KH, KV, RH and TH. Besides describing the various types suggestions are given relative to the design of an installation and the selection of units. Power and speed tables are given for 25 and 60-cycle and for the different types.

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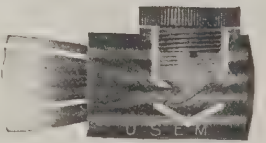

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Promoting the Electric Sign.

The one thing that gave the already famous Broadway of New York City the name "Great White Way," was the installation of magnificent electrical displays from Madison Square through the theatre district past 80th street. Many of these displays are made up of thousands of lights, hundreds of miles of wire and tons and tons of steel representing a large investment and around a hundred dollars for operating each one per week. When closely analyzed these displays are intricate electric signs. They represent the best of engineering skill and design ability, and their success has largely resulted from a careful working out of the many details of construction. In their design, the ideas of the structural steel engineer, those of the electrical and illuminating engineer and the artist are found.

Commercially these displays have been a wonderful success as advertising mediums, as is proven by the large number of national advertisers who use them and by those who are continually seeking a spot of advantage to erect a display. The spirit of this kind of advertising has spread throughout this country and has been taken up by merchants, manufacturers and others in small cities and even towns. In all cases they are eager to produce an effect "Broadway like" but in too many cases are contented with a means for producing this effect that is the product of the local sign painter, wagon painter or tinsmith, studded with incandescent lamps as individual taste for the light effect seems to indicate.

We appeal especially to central station commercial engineers, who usually act as advisers to purchasers of electric signs, to consider that the all-around efficiency of an electrical display depends mechanically and phychologically, like an advertisement, directly upon its design and attractiveness. Substantial construction is a basic necessity and only in so far as the sign embodies this feature in the presentation of an artistic display of letters or figures, can it be expected to bring permanent and satisfactory returns to the user and influence others to invest in similar installations. A profitable educational work for the central station commercial engineer or new business man presents itself here, for to promote electrical displays along proper and therefore along the most profitable lines, he must take a definite stand against the installation of flimsy signs, cheap in every sense, insisting that a sign besides presenting a good advertising idea, must be constructed to withstand the winds of a heavy storm, present no fire hazard, and be economical in the use of current consumed in rendering legible at night the features displayed. The greatest enemy of electric sign progress at this very time, in the medium sized city and the town of considerable size, is the poorly constructed sign.

A comment on electrical sign construction appearing in our oldest and worthiest contemporary, the *Electrical World,* is quoted in what follows: "In many towns the idea seems to prevail that any bell-hanging electrician or tinsmith can design and build a sign which will easily meet a wide range of service requirement, and as a result of this notion the fair face of the land is not seldom encumbered by hybrid installations which are not only ugly by daylight but which violate all the commandments of illuminating engineering by night, and at the same time break through the canons of sound mechanics by their inferior type of construction. As in most other matters, the production of an efficient, safe and effective sign is a problem for fairly expert treatment. Such questions as the location of outlets, the supply of energy, provision for replacing burned-out lamps, support of the sign structure, ease of erection, concealment of lamps in reflector types of signs to avoid glare, reduction of fire risks, protection of leads and sockets from the weather, use of templets in drilling outlet holes, accessibility for repairs, and relation between lamp spacing and legibility at stated distances, need to be worked out by more experienced heads and hands than can be found in the ordinary tin shop. Competition is close in this field and the exaction of thorough mechanical standards by the central station, combined with pretty severe electrical inspection, will gradually rid the industry of inferior equipment which is of doubtful benefit to the cause of permanently successful display lighting."

Reputable sign manufacturers are now keenly alive to the possibilities of the electric sign and anxious to see it promoted on a substantial basis. In most cases they even go so far as to furnish experts to consult on design and installation and otherwise co-operate with the central station new business man in his campaigns. In addition carefully prepared designs to suit particular conditions are furnished, as this seems to be the most logical way of presenting to a prospective buyer the effects that can be produced. The sign manufacturer is getting to a point, however, where he is inclined to believe that in a large number of cases, he is carrying a major part of the pre-sales expense for too often he is called upon in a haphazard way to furnish designs and assistance to central stations in much the same manner as the house-wife in the small town writes to the city store for samples of the newest fabrics, evidently believing that all that is necessary is to clip a few ends off the several bolts, never dreaming how many such clippings there may be to a yard that is worth some $3.00 or more. When several central stations call upon the sign manufacturer to submit a number of designs for signs, they call upon him to expend a definite and in many cases a considerable sum in the time of experts who could be doing productive work. When a request is made, it should be rather definitely known that the design can be sold. Otherwise the sign manufacturer should be advised of the conditions and permitted to investigate the situation so as to handle it to the best advantage. While it is true that the good nature of the sign manufacturer is too often overworked in this manner, and that he has a just cause for complaint, in most cases there is no feeling on the part of the central station that the sign manufacturer should bear an undue amount of the sales expense, the appearance of such a feeling being carelessly and thoughtlessly prompted by the overwrought enthusiasm that is often characteristic of successful new business getters in the central station field.

The situation is one that is squarely up to the central station salesman for if the local sign painter, the wagon painter, the tinsmith and the bell-hanging electrician are to be kept out of the sign business and the city ordinances unfavorable to the progress of electrical advertising allowed to slumber unwritten, some attention must be paid to the sales expense and construction problems from the standpoint of the manufacturer and a co-operation extended that will enable him to produce good signs at the prices that the majority of small purchasers demand. The central station is in a position to exert a beneficial influence in the promotion of electric sign and on account of the attractiveness of the load, with possibilities equal and in some cases greater than that of street lighting, these matters deserve serious consideration.

Public Utility Securities.

A financial authority has stated that over $500,000,000 must be raised by public utility corporations during the next twelve months to provide the public with the increased and better service that is now demanded. This it gives as the reason for the present tendency in formation of holding companies to manage from one control many properties and the reason why a steady stream of new public utility securities are being offered to investors with the approval and backing of the leading financial and banking interests of every city of any size in the United States. With the conditions attending the change of chief executives at the White House now settled, the American public will most probably during the coming year take a more general interest in public service investments than has been taken for some years past. This is a natural inference for the reason that what we call "bad times" effect the public utility company only in the slightest degree. These corporations are not subject to changes in our tariff laws, and the psychological effect upon their various fields of activity does not result in any reduction in the consumption of energy such as invariably follows a tariff agitation in the case of industrial companies.

The factors that have led up to and been the cause of the success of public utilities during the past few years are so connected with certain economic and social developments that have taken place in America, that these combined factors now stand as a mainstay in times of unsettled conditions. In brief, these factors are the substantial growth of American cities and their well formulated and regular demands for electrical energy and next the improved standard of living, a result of progress in urban and semi-urban localities, and the increase of wealth in these sections. Finally, the improvements in generating facilities and those of distribution have enabled the serving of a customer well at the lowest possible cost.

Commenting on the various phases of the public utility situation, a writer in the *New York Commercial* has the following to say on the subject of public utility securities: "Since the corporate form of investment security was first devised, bankers and investors have witnessed three successive and distinct financial investment periods in the United States. First, the construction, upbuilding and solidification of the steam railroad systems; second, the growth of manufactures and the evolution of industrials, and third, the present comprehensive development and consolidation or merger into holding companies of the corporations that supply our daily needs for home and business in the matter of light, power and heat and urban and interurban transportation. Such holding companies are not viewed by the public with disapproval, as in the case of steam railroads where competing lines have been placed under such control. Generally speaking the many public utilities holding companies organized during the past few years are looked upon with favor by both the public and investors. Employing as they do managers of highest ability at large salaries to operate their numerous properties, they render an improved and larger service which it is not possible for a single small property to provide at the hands of mediocre officers at small salaries. In addition the holding companies, dominated by able financiers of large resources and good standing, are enabled to immediately and properly finance the increasing capital requirements that are necessary to provide additions to plant, equipment, etc., and this, small local companies headed by small local capitalists, cannot so effectively do. So it may be said that two most important things are accomplished by public utilities holding companies—better service to their public and protection to their investors. In both of these two features too much praise cannot be given to the regulation of new financing and operation by those of our forty-three State Public Service Commissions that endeavor to serve with equal fairness the interests of the companies, the public and investors. Notably is this true as to the State of New York, for we of New York City have had striking proof of the impartiality and ability of our own Public Service Commissioners.

"Although the tendency is greatly toward the placing of numerous, scattered public utilities into the hands of holding companies, it must be understood that some of our most successful and prominent public utility corporations are not so controlled.

"The people of nearly every state are demanding and receiving more complete and improved service at the hands of their public utility stewards. And in this fact lies the greatest protection to investors in public utility securities. For as plant and equipment are brought to the high standard necessary to furnish greater and better service the security to investors is increased, as plant additions and maintenance and replacement values, etc., are taken care of.

"Stability of public utilities earnings, as compared with steam railroads and industrials, was sharply tested and to the former's advantage in the panic of 1907. During that time of financial stringency the more serious declines in security values appeared throughout the railroad and industrial list as traded in on the bond and share exchanges of the country. Public utilities securities held steadier because panics do not menace them as they do other issues. The daily needs of all the people continue pretty much the same; just about as many people ride on the trolly cars, burn electric and gas lights, and in other ways consume power just about as formerly. Hence earnings of public utilities do not drop with a thud during panics as did those of steam railroads and many industrials. Consequently interest payments and dividends by the well managed concerns are steady and continuous as a rule.

"The early hazards of the public utilities corporations were similar to those experienced by the steam railroads. Both suffered in many instances from overcapitalization and the evils that followed speculation and avarice. Receiverships in both directions up to the beginning of McKinley prosperity were not uncommon—in some years they were plentiful. Things have been better in recent years with both steam railroads and the other group of inter-related interests commonly called public utilities. Public and investors are treated better—the former are fast securing good service, the latter confidently place their savings and surpluses in the well seasoned underlying securities that are being widely offered by our leading banking houses."

A Noteworthy Lighting Exhibit by Illuminating Engineering Society.

A miniature exhibition of lighting and illumination effects shown by the Illuminating Engineering Society at the International Exposition of Safety and Sanitation in the Grand Central Palace, New York, December 11 to 20, 1913, was awarded a grand prize. In many respects this exhibit was remarkable and unique. First of all, it was an excellent example of how some of the facts of science may be made both interesting and instructive to nontechnical people. Many thousands of those who were fortunate enough to see the exhibit were filled with wonder and surprise. They had known, of course, that light, particularly artificial light, is one of their immediate necessities, but as to the numerous ways health and happiness are affected, few had better than a vague idea. That it may be employed to prevent a large number of industrial accidents and to promote industrial efficiency; that it may effect strange and sometimes comic distortions of statuary and other objects of interiors—these, not to mention other possibilities, were probably known to only a few. Side by side were models and pictures of good and bad lighting. Comparative conditions were clearly exposed. Uses and misuses of light, with their attending good or bad results, were indicated in ways which were at once striking and impressive. So apparent were the advantages and superiority of good lighting that one might have wondered why so many examples of bad illumination could be found. The latter fact is all the more curious when it is learned that good lighting may be had in many cases at a cost not much if any greater than that paid for the bad illumination, and in not a few instances it can be obtained for even less. It seemed evident that lighting may be good, bad or otherwise, depending largely upon the care and skill with which it is planned and how it is used.

Work of N. E. L. A. in Accident Prevention.

The committee on accident prevention of the National Electric Light Association is now planning a campaign to investigate all accidents that occur in the electrical industry, with a view to determining effective accident prevention devices and regulations. This committee is endeavoring to secure from central station managements and others, reports of all accidents whether resulting in injuries or not, so that the conditions can be best studied. It is not concerned in placing the liability for the accident nor in furnishing a basis for computing insurance rates, nor does it desire to know the name of the injured employe or his wages. In all cases the accident report as received will be used by the committee in a confidential manner, and will not be given publicity save in such aggregate statements as will be made to the association from time to time.

The facts about which the committee is seeking information are: What accident happened? What was the nature of the accident? What caused the accident? What part of the employe's body was injured? How serious was the injury? Can the recurrence of such accident be prevented? How can it be prevented? This is a work that should receive the careful attention and liberal cooperation of every central station manager and employe, for by such action the committee will soon be in a position to make helpful suggestions for accident prevention.

Second Hydroelectric Development on the Ocoee River by Tennessee Power Co.

(*Written Exclusively for* Electrical Engineering.)

Section 1. The Hydraulic Details of Ocoee Station No. 2 of Tennessee Power Co., Polk County, Tenn., at Mouth of Caney Creek.

Station No. 1 of the Tennessee Power Company on the Ocoee River of 18,750 Kva capacity was described in the December, 1912, and April, 1913, issues of *Electrical Engineering*. In this issue further details will be taken up in connection with the company's developments, more particularly the one known as Station No. 2 on the Ocoee river at the mouth of Caney creek.

After arrangements were completed for delivering power to Chattanooga (Tenn.), Rome (Ga.), and Cleveland (Tenn.), from Station No. 1, it was at once apparent that the demand would soon be beyond the capacity of this development, especially in view of the fact that Knoxville (Tenn.), and Nashville (Tenn.), would become large consumers of power as soon as transmission lines to these two cities were completed. This condition called for the immediate development of a reserve site above the Parksville or No. 1 reservoir, the surveys and plans for which had already been made, and formed a part of the ultimate system. The work on the No. 2 station then, started in May, 1912, was somewhat in advance of original plans due largely to the unexpected power demand, a result of the Tennessee Power Company's system being the first large water power project to be placed in operation in Tennessee.

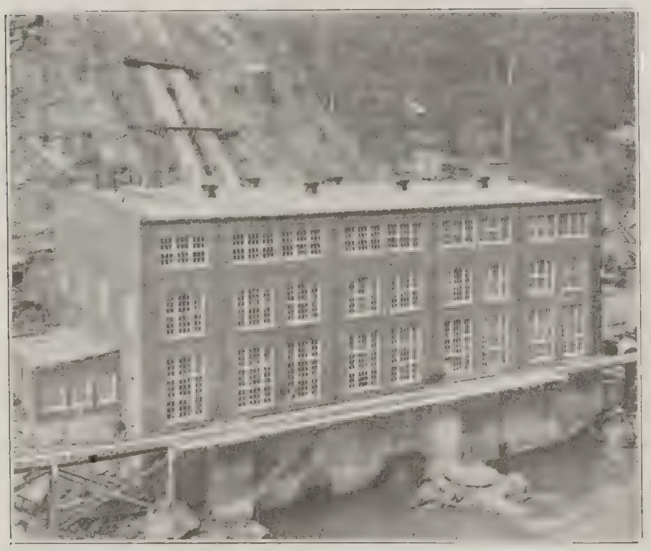


Fig. 1. Power Station No. 2 on Ocoee River, Showing Penstocks, Cooling Water Tank on Hill and Lightning Arresters on Roof.

The plans for the No. 2 development on the Ocoee river called of the utilization of the power of this river which could be developed from the six miles of fall immediately above the back water of the Parksville dam. In this stretch of the river the fall is more than 250 feet and utilized by a diversion dam feeding a flume which leads to the penstock and then to the water wheel at No. 2 power house. The plans as adopted called for a power house situated opposite the mouth of Caney creek, which empties into the Ocoee about 4,000 feet above the back water from the Parksville dam, which back water extends eight miles from this dam.

The water for the wheels is brought by flume from the diversion dam situated 4¾ miles up the river from the power house by following the river but about 2½ miles in an air line. As stated, the fall of the river in this distance is over 250 feet and the final layout gives the bottom of the flume intake at 1095 feet elevation with bottom of flume extension intake at the fore-bay at elevation of 1077 and the elevation of the water wheel shaft at 851.5 feet above sea level.

FLUME TO POWER HOUSE.

The flume extends from the power house to the diversion dam 4.6 miles up the river. As this flume is one of few, east of the Rocky mountains, its construction is of interest. The almost perpendicular sides of the mountains required a large amount of excavation in order to obtain footing for the flume box. In places the grade for the flume box had to be cut out of solid rock requiring considerable blasting. The amount of dynamite used was about six car loads of 24,000 pounds each and the amount of excavation, chiefly rock, for the flume box was 289,000 cubic yards. This gives an idea of the amount of work preliminary to the construction of the flume box proper. As already stated, the water was made to enter the flume by means of a diversion dam. At a point just before reaching the penstocks, the flume enters a fore-bay or equalizing basin. This basin acts also as a settling basin and takes care of the overflow. From this fore-bay the flume extension runs to the penstock intake. Each of which will be described later.

The diversion dam is built at a point where the river is comparatively wide. The dam is of crib construction, built of 10 by 10-inch timbers. It is provided with five sluices which were open before water was diverted into the flume. These sluices were of a temporary nature and were closed by gates on the up stream side. Gate guides are provided and provisions made for opening these gates if desired for sand sluices.

At the south end of the diversion dam, built in concrete solid with the bank of the river, is the flume intake. The

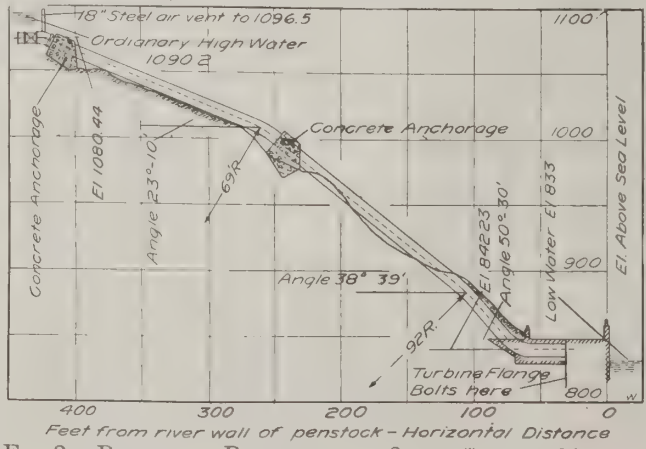


Fig. 2. Profile of Penstock for Ocoee Station No. 2.

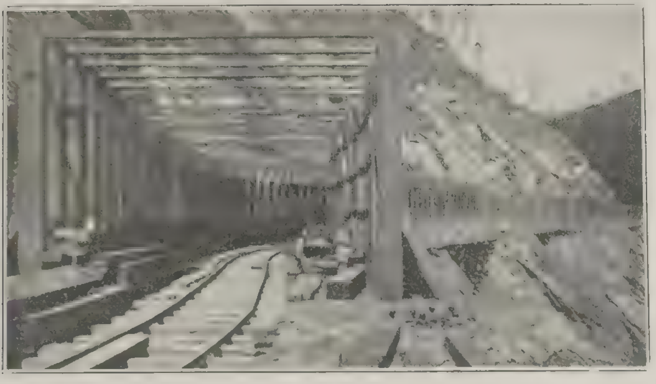


FIG. 3. FLUME SECTION SHOWING CONSTRUCTION ON ROCK CLIFF.

opening on the up stream face of the dam is 16 ft. high by 30 ft. wide. The top of the opening is at elevation of 1106.25 which is 1.0 ft.—3-in. below the crest of the crib dam. Across this opening are the iron racks to prevent the passage of timber, etc., into the flume. The opening narrows after passing the racks so that, after the gate at the flume entrance is reached, the opening is 10.78 ft. high by 14 ft. 2-in. wide. At this point is the Tainter gate which admits water into the flume proper. This gate is shown in the illustration as a segment of a cylinder acting on an axis which corresponds to the axis through the center of the cylinder. The axis of the gate is set in concrete as shown. The gate is operated by a chain and gear train located on the concrete roof of the intake. This roof is at elevation 1119.5 and thus much above the crest of the diversion dam. The plan and section of the flume intake are shown in the sketches.

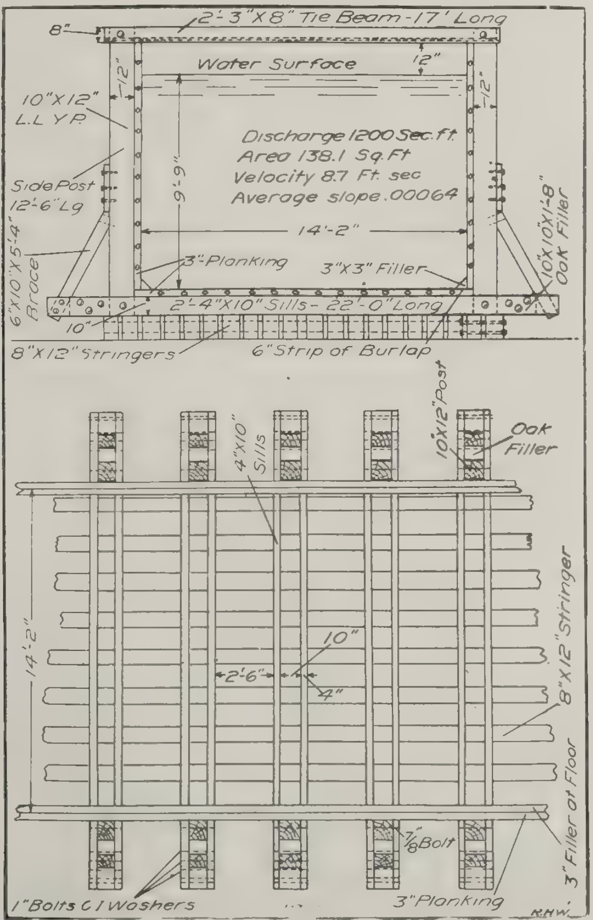


FIG. 4 AND 5. SECTIONS OF WOOD FLUME BOX SHOWING CONSTRUCTION.

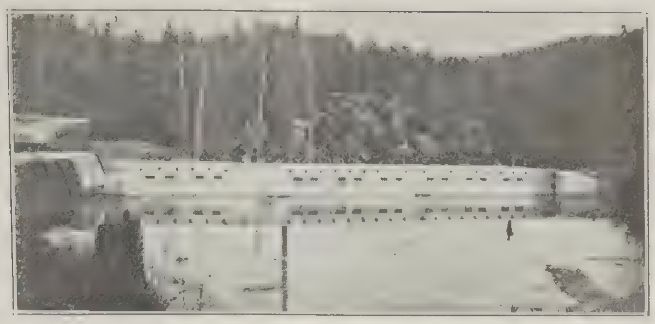


FIG. 6. SYPHON SPILLWAY AND FOREBAY SHOWING RACKS AT FLUME EXTENSION AT THE LEFT.

FLUME.

From the intake at the diversion dam, the flume extends to the fore-bay, which is about 300 feet from the penstock intake. In the length of the flume, the flume box varies in its anchorage from clay to solid rock and in places on peg-leg wooden trestles and on steel viaducts. Since the flume follows the sides of the mountains, there are very few tangents in its full length and the longest of these is about 300 ft. The center line is a succession of arcs of circles of varying radii and to make the flume conform to the curvature was an item in construction. Since the flume lining is of 3-in. yellow pine, it can be seen that much additional labor was required by the curvature of the flume, but this was small compared with the additional excavating required to increase the length of the tangents. From the flume to the fore-bay five steel viaducts were required, with spans of 216, 132, 288, 190 and 156 feet with corresponding heights above lowest pier 61.5, 36.44, 108.7, 71.27 and 42.66. One of these viaducts was a 33 degree curve in a radius of 176.04 ft.

The cross section of the flume as shown will give an idea of the construction. As shown the 4 by 10-in. sills which hold the side posts rest on 8 by 12-in. stringers. There are two 4 x 10-in. sills for each set of side posts. The posts are clamped between the two sills and braced by

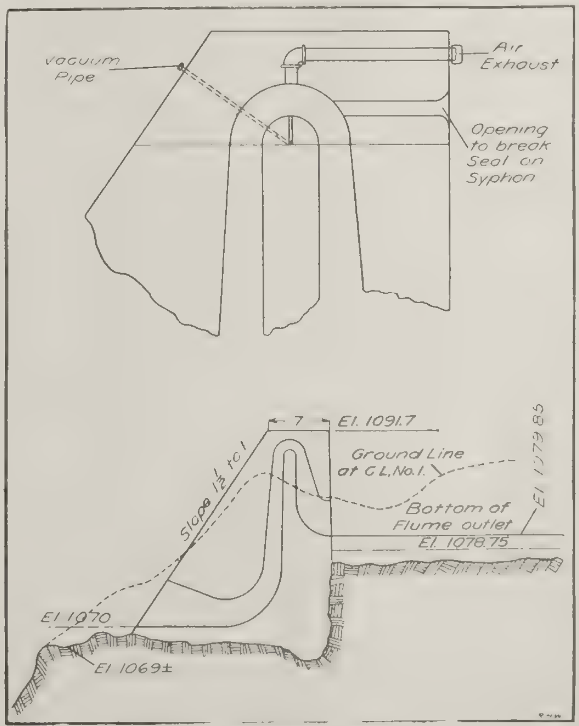


FIG. 7 SECTIONS THROUGH SYPHON SHOWING AIR PASSAGES TO TOP OF SYPHONS.

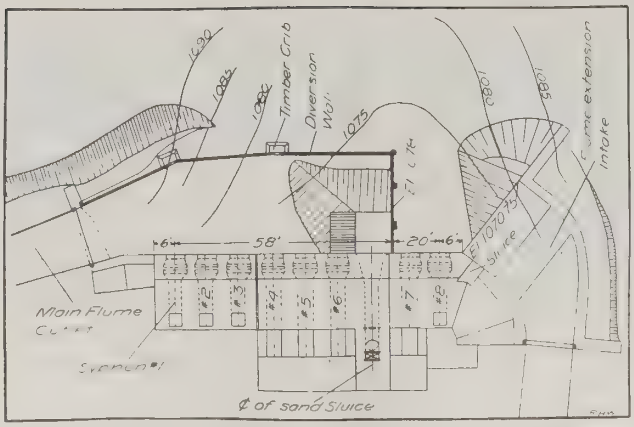


FIG. 8. PLAN OF FOREBAY SHOWING SYPHON SPILLWAY AND SAND SLUICE.

a 6 by 10-in. brace on each side. This brace is also bolted between the two sills. At the top, the side posts are bolted between two 3 by 8-in. tie beams which keep the posts rigid and allow for no spreading. The side posts and stringers are spaced 2.5 ft. as shown on the sectional plan. The flume lining consists of 3 by 12-in. timber grooved for ¾ by 1⅝-in. splines. The 8 by 12-in. stringers as shown in the sketch are used where the flume crosses viaducts or peg-leg trestles only. Elsewhere the stringers are reduced in number on rock foundation and in layed concrete stringers well formed by digging trenches in the direction parallel to flume. Concrete was poured in these trenches forming the stringers. At short intervals in the concrete stringers, openings were left to allow for drainage under the flume box proper and through the flume length tile pipe was used under the stringers to provide proper drainage.

As shown in the sketch, the flume box proper is 14 ft. 2 in. wide and 10 ft. 9 in. high, giving an area of 138.129 sq. ft. The flow is calculated at 1,200 second ft. with a velocity of 8.7 ft. per sec. The elevation at the bottom of the flume at the intake is 1095.47 and at the outlet to the fore-bay is 1079.55, giving a drop of 15.62 ft. between diversion dam and fore-bay, with a slope of .00064. The drop in the flume line is greater than the depth of the flume box.

To provide for an emergency when the flow will be so great that the syphon spillway in the fore-bay can not take away the water fast enough, spillways are provided at points along the flume where the drainage is suitable, by cutting the side of the flume down to a depth of 8 ft. from the bottom. This wall allows the water to spill over along the route of the flume without flooding over the fore-bay. With the flume section cut to allow an 8 ft. depth in the flume, a flow of 800 second ft. is provided for. This is the amount of water which is required at full load on the two units now installed. Where the temporary spillways are provided in the flume, the 6 by 10 in. braces on the spillway side are boarded up so as to shed water. These spillways are located at points where there is a good natural drainage or rock surface so that the water will not damage the flume bed in any way.

A standard gauge track is laid on the top of the flume with 30-lb. rails fastened to the tie beams. A derrick car is used on this track for inspection and repair purposes. On the top of the flume is also placed a board walk for the convenience of inspection. The telephone line between the power house and dam is run along the flume and has insulator brackets spiked to the side of the flume. In this way the inspector can conveniently telephone to the power house. The amount of lumber used in this flume construction was about 8,000,000 board ft., all of which had to meet rigid specification under inspection, being chiefly long leaf yellow pine with some oak.

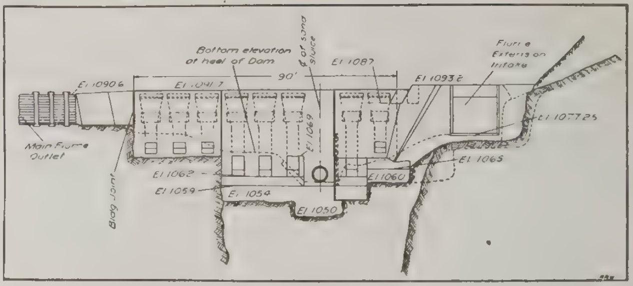


FIG. 9. ELEVATION OF SYPHON SPILLWAY SHOWING SYPHONS AND SAND SLUICE.

As already stated, at a point about 300 ft. from the penstock intake, the flume empties into the fore-bay. This fore-bay acts as a settling basin and surge tank and takes the fluctuation of water inflow above the demand at the penstock. This fore-bay is built at a point where a ravine existed and consists of a concrete dam with 8 syphons built in. This concrete dam joins the flume outlet and flume extension intake as shown in the illustration. At the lowest point of the fore-bay a valve is located which can be opened and used as a sand sluice. On the side of the fore-bay between the center line of the sand sluice and the flume extension intake is a log wall which serves as a deflector and aids in settling the sand.

This syphon spillway is one of the unique features of the installation. This type is patented and there is only one other spillway of this type installed in this country. Eight of these syphons are installed in the spillway, as shown in the sketch. The top of the syphons, as shown, has a vacuum pipe so that the degree of vacuum can be read. There is also an air exhaust pipe which is sealed and pipes at the level of the top of the syphon for breaking the seal when the water level is lowered to this opening. Otherwise the syphon action would continue until the water was lowered to the level of the syphon intake. The action is that the water can rise until it flows over the top of the syphon and seals the pipe opening, when the syphon action starts and the full flow continues until the water is lowered and the seal is broken. Otherwise the syphon flow would continue until the syphon intake were exposed.

On the opposite end of the fore-bay from the main flume outlet is the flume extension intake, which extends from the fore-bay to the penstock intake. As shown in an illustration presented here, racks are placed in the fore-bay where the water enters the flume extension. The

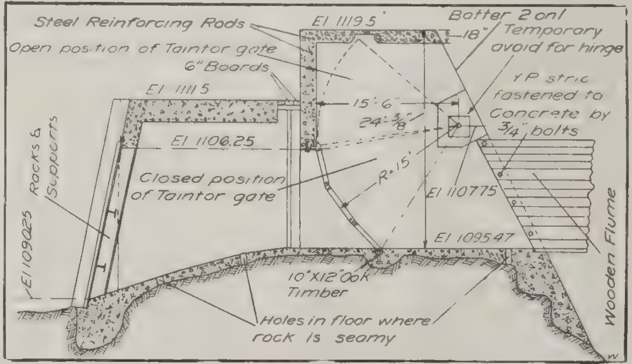


FIG. 10. SECTION THROUGH FLUME INTAKE AT DIVERSION DAM.

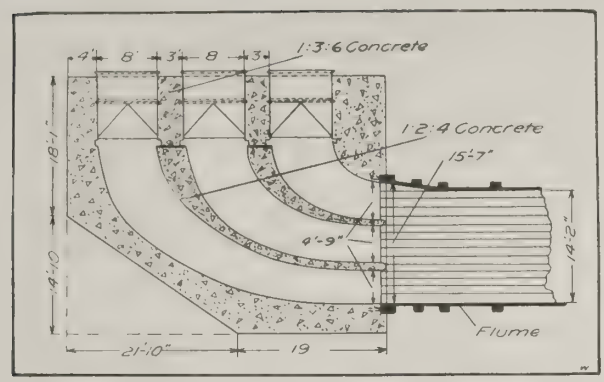


Fig. 11. Section of Penstock Intake.

flume extension is similar to the main flume, except that the height is increased with a corresponding increase in the size of the side posts. The flume extension depth is 15 ft. from the bottom of the flume box to the tie beams at the top. The side posts are 12 by 12-in. and there are 1⅜-in. tie bars at a height of 11 ft. from the bottom of the flume. Also instead of wooden braces on the side of the side posts, ⅞-in. loop bars are used from the end of the 6 by 12-in. sills to a plate on the outside of the side posts through which the tie bars pass. The floor of the flume extension is 4-in. thick and the side lining is 3-in.

From the fore-bay to the penstock intake, the flume extension is covered with an expanded neutral screen of 2½ in. mesh, which is fixed to the beam at the top. The bottom elevation at the extension intake is 1077.25 and at the penstock is 1076.44 giving a slight slope. For a flow of 1200 second ft. the elevation of the water surface in the flume extension is approximately 1087.2 ft.

The flume extension connects to the intake for the three penstocks. The intake for the three penstocks leave the flume extension as shown in the sketch, each intake curving on a different radius. The intakes are of concrete 4 ft. 9 in. wide and 9 ft. 9 in. high at the extrance, with the section changing from rectangular to circular at the penstock proper. The upper section of each penstock is imbedded solid with the concrete intake. This section for No. 3 penstock is provided with a bulkhead since No. 3 penstock has not been installed complete.

From the penstock end section, the penstock, made up of riveted steel lap jointed, drops direct into the power house, making three angles with the horizontal of approximately 23, 38.5 and 50.5 degrees. It is anchored in two places between intake and power house by means of concrete saddles covering the anchor angles. Man doors are made in these penstocks about half way up.

Each penstock is equipped with a butterfly valve forming the section next to the end section at the intake. These valves are of the vertical shaft type operated by a worm gear by hand and also by motors controlled from the power house. The control cables for these motors are run from the power house in conduit anchored to the penstock. Very little power is required to operate these valves, being easily operated by one man or a 5 Hp motor. Each motor is provided with a limit switch so that the circuit breaker at the power house is opened when the valve has reached the end of its travel. Each penstock is supplied with an 18-in. steel air vent in the section next to the valves, which vent rises above an elevation of possible high water in the flume. Just before the penstocks enter the power house they each make a bend so that the distance between center lines of No. 1 and No. 2 is 53 ft. At the intake, the distance between center lines is 11 ft. and the penstocks do not begin to separate until near the power house, where they make reverse angles of about 32 degrees. Inside the power house, each penstock is tapped by a supply pipe for the cooling water tank which is located on the side of the hill above the power house.

This water tank is of riveted steel, circular in section, 12 ft. 6-in. in diameter and 12 ft. 3-in. high. The supply pipe is 4 inches in diameter and connected to both penstocks, having a valve at each penstock so that the supply can be taken from either penstock or from both at the same time. The water supply enters the tank near the top and is controlled by a float valve inside the tank. The tank outlet to the transformer is taken one foot from the bottom of the tank, and this outlet is screened by a ¼-in. wire mesh so that solids cannot enter the transformer cooling coils. Near the top of the tank is an overflow leading to the tailrace. This overflow also connects to the 6-in. drain pipe in the bottom of the tank which is used for cleaning purposes.

The purpose of this cooling water tank is to reduce the head of the water on the transformer cooling coils and also to serve as an aerating tank so that air bubbles will not enter the cooling coils. Air bubbles would be objectionable because of resultant oxydization of the coils. The tank elevation is about 80 ft. above the power house floor so that the pressure on the cooling coils is about 35 lbs. per square inch. The head on the water tank intake is about 145 ft. giving a pressure of about 63 lbs. per square inch. The tank capacity available is about 10,000 gallons while the transformers each require 47 gallons per minute under full load conditions.

The piping is arranged so that the water from the penstock can be put through the transformers direct without going to the aerating tank. This can be done by simply opening a valve which allows the water to pass through a basket strainer direct into the cooling coils.

The next section of this article will take up electrical details.

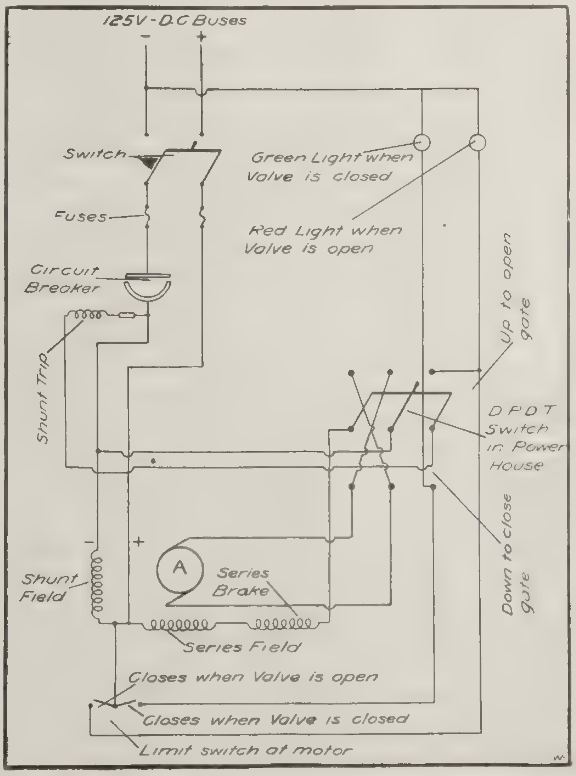


Fig. 12. Penstock Valve Motor Control.

The Design of Steam Plants

(Contributed Exclusively to ELECTRICAL ENGINEERING.*)*

BY EARL F. SCOTT, M. E., MEMBER A. S. M. E., MECHANICAL ENGINEER, ATLANTA, GA.

Section 8. Design of a Combination Power Station and Ice Plant.

IN the sections of this article already presented in these columns the writer has discussed turbine installations where condensing and feed water is easily secured, and in the last section completed the discussion of a combination engine and turbine equipment. It seems desirable now to take up other variations of plant design where turbines are used leading up to a discussion of those plants in which engines are important considerations in the design. The designs that will be discussed in the sections to follow will be suitable for stations serving light and power to communities of average and small size. In this section the writer will take up the design of a turbine plant in connection with which a 50-ton electrically-driven ice plant is operated. Good feed water will be available, but a limited supply of water for condensing purposes either from deep wells or from the city mains.

It is common to find inland towns where, in considering the construction of a steam plant, the securing of an economical supply of condensing water is a serious problem. Further, in many sections of the south the water available in large quantities is not suitable for steam boiler operation without treatment. A discussion of the handling of such conditions in determining a design of a plant will, therefore, be considered. In the case of a small plant, required to serve a small city, it is desirable at the start to work up a careful load curve showing the possible demand for light and power. This is advisable on account of the fact that in such towns the load is at best a variable one, with little possibility of immediately filling up the valleys during the day with any considerable motor load, nor at night with public signs or other good load factor loads. With the larger plants in larger centers of population, these conditions are not as bad, for there is always a considerable opportunity for an aggressive manager to make loads and hold as his aim a straight line load curve.

Since the ice plant to be operated will require distilled water for ice making, as well as considerable electrical power, this service will call for two things: First, the proper selection of condensers to produce a condensate for the ice making, and, second, a type of motor drive that can be operated to the advantage of the power plant as practically a 24-hour service. These conditions we will term natural. While they are more or less flexible, they are practically constant quantities and must be dealt with accordingly by the designer. Other natural conditions are ample ground space for the location of the plant and the cost of coal. While the coal cost at the mine may be variable, the freight rate on same is fixed to a certain extent, and the average conditions make possible a coal cost at the boiler room of $3.50 per short ton. In the course of the discussion it will be shown how a higher price may be paid for a higher grade of coal, based on the evaporative effect produced in the boilers. In considering the water problem, the question of surface condensers and jet condensers and the use of evaporators must be settled, as well as a consideration of cooling towers and a spray nozzle pond.

For convenience in discussing the various features of the design, an imaginary load curve has been worked out, as shown in Fig. 1. This curve shows a combination service of light, power and railway loads. From it we shall choose one 500 kw. and one 750 kw. turbine, planning on the installation of a 1,000 kw. unit when the service shall demand an increased capacity.

SELECTION OF BOILERS.

We shall assume a water rate (steam) of 22 pounds per kilowatt for the turbines as an estimate, not including the charge required for auxiliaries. While it may be possible to secure a better guarantee than assumed for estimating purposes, it cannot be expected that a turbine will run up to its guarantees under continuous service. The boilers will respond to any overloads under which the turbines will operate, so that full load conditions can be considered in determining boiler capacity.

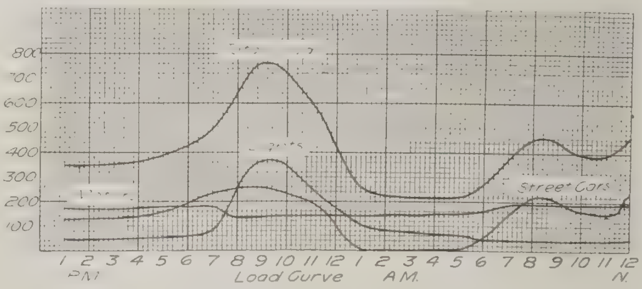


FIG. 1. LOAD CURVE FOR PLANT UNDER CONSIDERATION.

Therefore 750 × 22 = 16,500 lbs. of steam per hour. To this should be added 10 per cent for auxiliaries, giving a total of 16,500 plus 1,650, or approximately 18,000 lbs. per hour. Thus, 18,000 ÷ 30 = 600 Bhp. required to operate the plant at full load. From a study of the load diagram it is observed that for about 12 hours out of the 24 only 500 Kw. capacity is required. This will require 500 × 22 = 11,000; with 10 per cent for auxiliaries added, equals 12,100, or approximately 12,000 lbs. of steam per hour. Then 12,000 ÷ 30 = 400 Bhp. From the first consideration or maximum load we see that units of 300 Hp. would probably be chosen, but from the second consideration it seems advisable to choose either smaller or still larger units. From further study of the load diagram we find that during twelve hours the 500 Kw. machine will not be operated at full capacity. Therefore one 300 Hp. boiler would handle the load during this period, and two 300 Hp. boilers would work out satisfactorily for the peak load. Since a reserve boiler is required for cleaning and repairs, the selection of boilers should be three 300 Hp. units. These should be arranged in one battery and a half-battery, with a third boiler so bricked up that, when the plant expands a fourth unit can be added without destroying the symmetry of arrangement.

For a plant of this size and character the writer believes that best results can be obtained by operating at a steam pressure of 200 pounds gauge and a vacuum of 27 inches, referring to 30-inch barometer. A better steam economy would probably result with a better vacuum, say 28 inches, yet it would be paid for dearly, since circulating water for cooling purposes must be pumped. Better results can be secured by running at a high steam pressure and thereby securing a larger difference between the maximum and minimum steam temperature, over and above the conditions with a lower vacuum.

SURFACE VS. JET CONDENSERS.

As to a choice between the surface and jet types of condensers, it might seem advisable on first thought, as far as saving steam of condensation is concerned, to select the surface type; but, since this class of apparatus requires more cooling water than the jet type, and since the supply of water is limited, the selection of condensers must have further consideration. For the surface condenser we have the following conditions and requirements:

For the 750 Kw. machine, 750 × 22 = 16,500 lbs. of steam per hour that must be condensed at 27-inch vacuum. Each pound of this steam has 1,149 Btu.'s of heat. The temperature of steam at 27 inches vacuum is 114 degrees F. Therefore we must remove 1,149 — 114 = 1,035 Btu. from each pound of steam, or a total of 16,500 × 1,035 = 17,077,500 Btu. per hour.

In considering the surface condenser to do this work, the cooling surface required must be determined and the amount of circulating water required per hour. It is good practice to assume about 300 Btu. transmission of heat per degree difference per square foot of cooling surface. We may also assume an initial water temperature at 80 degrees F. The final water temperature will depend somewhat on the state of cleanliness of the condenser tubes, and may be expected to be within 8 to 10 degrees of the steam on the outside of the tube. In the case under consideration, 114 — 10 = 104 degrees F. would be the final temperature of water. The average temperature of the water in the tube would then be ½ (80 + 104) = 92 degrees F. The temperature on the outside of the tube is 114; therefore the difference between the outside and the inside of the tubes will be 114 — 92 = 22 degrees, and each square foot of surface (copper) will transmit 22 × 300 = 6,600 Btu. per hour. Since a total of 17,0777,500 Btu.'s must be dissipated per hour, 17,077,500 ÷ 6,600 = 2,587 square feet, or approximately 2,600 square feet of condenser surface.

On account of the low temperature of steam at 27 inches of vacuum, the difference between inside and outside temperatures of tubes is small and necessarily requires a large tube area for the condenser, making the apparatus very expensive. Since the temperature of the vacuum at 28 inches is 100 degrees, it can readily be seen why the apparatus would be so expensive.

The amount of circulating water required in order to produce this vacuum is determined as follows: From the considerations already taken up it is seen that each pound of water will dissipate 104 — 80 = 24 degrees of heat, or practically 24 Btu. Since a total of 17,077,500 degrees or Btu.'s must be dissipated, this quantity, divided by 24, equals 711,562 lbs. per hour, or 711,562 × .002 = 1,422 gallons per minute of circulating water.

Since this water must be pumped over a cooling tower continuously, any method of reducing it should be considered. If we resort to the jet condenser we lose the water condensed, yet it may pay to throw away this water and use evaporators to supply distilled water for ice making. In considering the surface condenser it was observed that we could not approach the temperature of the vacuum with the water closer than 10 degrees. With the jet type condenser it is possible to come within 3 degrees of this temperature; and, with this as a basis, we find that one pound of water will absorb (114 — 3) — 80 = 31 degrees or Btu.'s and 17,077,500 ÷ 31 = 550,900 × .002 = 1,102 gallons of circulating water per minute required with the jet condenser. By its use, therefore, we save in circulating water 1,422 — 1,102 = 320 gallons per minute during 24 hours of the day.

The cooling tower required will be about 40 feet above the level of the circulating pump, and the friction head due to bends, etc., will be about 5 feet; therefore the pump. horsepower required is (45 × 320 × 8.33) ÷ 33,000 = 3.63 Php. The pump efficiency will be about 60 per cent and the driving motor about 90 per cent, so that the power required will be (3.63 × 746) ÷ (0.9 × 0.6 × 1,000) = 5.04 Kw. And 5.04 × 24 = 121 Kw.-hrs. per day. Considering this current worth about 1½ cents per Kw.-hr. at the switchboard, it will cost 121 × 1.5 = $1.81 per day more to pump circulating water for the surface condenser than for the jet condenser. This represents $630.65 per year, which, at 6 per cent, represents an investment of $10,500; or, in other words, if the evaporator arrangement does not cost more than this amount, plus the amount of coal to operate the evaporators per year, it will pay to install the jet condenser and evaporators.

There is very little published information on evaporators, especially those suitable for multiple effect. Normally in steam practice we evaporate a pound of water, carry it through a prime mover down to atmospheric or vacuum pressure, condense same, and secure the original pound of water in a distilled state. In the evaporator this process is duplicated, with the addition that the steam delivered to one evaporator is condensed, and, in giving up its heat, evaporates another fraction of a pound of water at a little lower pressure and temperature. This process can be carried through several generators in series or effects, passing through a pressure range from say 125 pounds steam pressure to 26 inches of vacuum. In order to work economically through this range, possibly an eight effect arrangement would be required. This means that eight different evaporators are connected, each in series or parallel, under the conditions just named; and with steam at 125 pounds gauge in the first effect, and with heating surface to produce a temperature difference of 30 degrees F., we would generate steam in the first effect that would be available for the second effect as follows: 125.3 pounds gauge = 140 pounds absolute with a temperature of 352.8 degrees. A 30-degree difference equals 352.8 — 30 = 322.8 and a gauge pressure of 78.3 pounds. Thus the pressure is reduced through the evaporators. The design of the apparatus is such as to work itself out properly between the limits. In other words, a four effect would have a different degree difference considered in the design.

In choosing an evaporator arrangement, it is not always best to select the high effect arrangement on account of the cost to produce a high efficiency. A 50-ton four effect evaporator arrangement, erected ready for operation, from 125 pounds steam to 25 inches of vacuum, would cost about $4,500. A six effect, operating under the same conditions, would cost about $6,500. An eight effect plant would cost about $8,700.

A four effect equipment operating under the above-named conditions would require 1,675 pounds of steam from the boiler per hour. The six effect would require 1,060 pounds and the eight effect 950 pounds. The coal required to operate the four effect arrangement is $(1{,}675 \times 24 \times \$2.50 \times 365) \div (8 \times 2{,}000) = \$2{,}281.25$ for fuel per year. The six effect would require $1,714.05.

Since only $630.65 is saved per year by operating the jet condenser instead of the surface type, and since more than this is required to operate the evaporators, it is at once seen that it will not pay to install the jet condenser and evaporator arrangement. The surface condenser is, therefore, the proper selection. It is necessary now to decide as to whether or not enough condensate will be produced in twenty-four hours with this arrangement to meet the demands of the ice plant, and as to whether or not it will be necessary to install a small evaporator plant to make up the difference.

By referring to the load curve again, it is found that the average demand is about 400 Kw. per hour; and since the small machine can be run at night to carry the small load, full load can be carried on the machines operated continuously, and under these conditions we may expect a steam consumption of about 22 pounds per kilowatt hour, or $400 \times 22 \times 24 = 211{,}200$ lbs. per 24 hours, or 105.6 tons per 24 hours, or twice as much distilled water as would be required for ice making. The excess can be carried back to the boiler through the feed water heater.

COOLING TOWER VS. SPRAY NOZZLE SYSTEM.

The next consideration is the selection of a method for cooling the water, and a cooling tower and spray nozzle system will be discussed

Referring to the load diagram, it is observed that the peak comes after the hot part of the day, and that the large turbine will not be overloaded, so that a cooling tower can be considered that will handle about a 500 to 700 Kw. plant. In addition to the cooling tower, a retaining basin about four feet deep will be required to catch the water. The tower required to serve such a plant capacity would be about 30x90x30 feet high and the basin about 30x90x4 feet deep. If the basin is constructed of concrete, 9 inches thick for bottom and sides, about 94 cubic yards will be required, which will cost about $10 to $12 per cubic yard, making the total cost of the basin about $1,123. The cooling tower proper would cost about as follows: A cypress wood tower costs about $3 to $4 per gallon of water cooled. The tower in the case under consideration will be required to handle 1,500 gallons of water, and, on the above basis, would cost $4,500. This is exclusive of a fan if it is a fan type tower, and, if not, would probably cost something more, as a larger tower would be required. For the fan type tower, the motor to drive the fan would cost about $400 to $450, including the fan. The belt would cost about $75 and the pipe work about $300. Therefore for the cooling tower costs we have the following:

Concrete basin	$1,123
Wood for tower	4,500
Motor and fan	450
Belt	75
Pipe work	300
Total	$6,448

In considering the spray nozzle arrangement, it is considered that about one square foot area of cooling pond is required for every 200 pounds of water sprayed per hour for plants of 1,000 Kw. capacity, and for plants of from 500 to 750 Kw. one square foot for every 175 pounds per hour. Since 1,422 gallons of water must be cooled per minute, or 687,000 pounds per hour, this figure, divided by 175, equals a pond of 3,925 square feet area. A pond, therefore, 40x100x4 feet deep will fulfill the requirements. Considering a concrete basis, as in the previous case, such a basin of the dimensions given would call for about 142 cubic yards of concrete. At a cost of $12 per cubic yard, the construction would cost $1,704. In considering nozzles and pipe work, we will assume a pressure of eight pounds and a one-inch orifice for the nozzles. Under these conditions one nozzle will throw 75 gallons of water per minute, and will thus handle 1,422 gallons by means of 20 nozzles. These nozzles will cost about $25 each, and the necessary pipe work will cost about $1,000. The total cost is as follows:

Concrete basin	$1,704
Twenty nozzles at $25	700
Pipe work	1,000
Total	$3,404

The operating expenses in connection with the spray system per year are as follows:

$(1{,}422 \times 8 \times 8.33) \div (33{,}000 \times 43) = 6.65$ Php. and $(7 \times 746) \div (0.9 \times 0.6 \times 100) = 9.9$ Kw., or approximately 10 Kw., which, at 1.5 cents per Kw. hour, equals 15 cents per hour as cost of operating pump. Then $.15 \times 24 \times 365 = \$1{,}314$ per year.

COMPARISON OF COOLING TOWER AND SPRAY NOZZLE SYSTEM COSTS.

Cooling Tower.	
Basin	$1,123.00
Tower and piping	5,325.00
Total first cost	$6,448.00
Operating expenses	2,102.40
Spray Nozzles.	
Basin	$1,704.00
Nozzles and piping	1,700.00
Total first cost	$3,404.00
Operating expenses	1,314.00

With the spray nozzle system it is seen that a saving of $1,921 can be made on first cost and $808.40 in operating expenses per year. There will be days in summer when it will be probably necessary to force the water through the nozzles twice in order to get the temperature of the water below that of the air. This would not occur often and only for a few hours of any day.

The following data is secured from a plant at Birmingham, Ala., for May 28, 1912, where a No. 12 spray nozzle is used:

	First Spraying.	Second Spraying.
Temperature of air in degrees F.	87	88
Relative humidity in per cent	48.5	46.0
Temperature hot water	122.5	88.7
Temperature cooled water	88.3	78.8
Total degrees cooled	...	44.1

The following data was taken from the log sheet of a plant where spray nozzles are in operation serving a 6,000 Kw. installation:

Month.	Temp.	Time 8 a.m.	Time 12 m.	Time 4 p.m.	Weather Conditions
July—					
Hum'ty	T_1	108	118	118	Clear
70%	T_2	90	93	93	
	T_3	90	98	102	
August—					
Hum'ty	T_1	112	114	116	Cloudy
84%	T_2	88	89	90	
	T_3	72	74	79	

T_1 is temperature of discharge water in degrees F.; T_2 is temperature of water after spraying; and T_3 is the temperature of the surrounding air. The humidity was taken at 8 p. m.

These data give some idea of the operating possibilties of spray nozzles. For a well-designed cooling tower, operated under average conditions, water may be cooled to the temperature of the surrounding air, or possibly a little below if the humidity is not greater than about 70%.

In the next section of this article the writer will discuss the nature of water supply for the plant under consideration—namely, from deep wells or from city mains.

Requirements and Revenue of Small Central Stations

(Practical Commercial and Technical Suggestions.)

BY T. EDWARD KEARNS.

A Discussion of Costs of Equipment and Possible Revenue of Small Plants.

THE tendency toward consolidation of small central station plants and the serving of small communities from a central distributing system, is one presenting serious considerations to those served as well as the stockholders of such plants. A discussion of this tendency, as well as the service requirements of the small town, was presented in a practical and interesting way by J. Edward Kearns at the last N. E. L. A. convention, and we present an abstract of his remarks in what follows: The purpose of the paper was expressed under three headings: (1) To interest those now operating successful plants to investigate the unprofitable ones in their proximity, with a view either to selling power wholesale to such plants or taking them over and operating them. (2) To investigate the desirability of extending service to some of the near-by towns and villages that are not enjoying the benefits of electric service, and to provide preliminary facts and figures on the cost of such installations. (3) To offer some suggestions for improving the income of the present small plant.

It is a well-known fact that nearly every station can increase its plant load-factor by improving the off-peak operating periods, and this may be brought about by developing the diversity factor of the plant, as the demands upon a distribution system vary from time to time, depending upon the period of the year, the habits of the people served, and the character of the district—whether residence or manufacturing. In certain classes of service the maximum demand comes late in the afternoon, such as, for example, store lighting and later in the day residence lighting, while in the manufacturing districts the load comes on in the morning, reaching its maximum about 10 a. m., except during certain months when light is required, and then this maximum demand usually occurs about 4 or 5 o'clock in the afternoon. The combined effect of all these various applications results in a smaller maximum demand at the station than elsewhere on the system—that is, the total of the maximum demands at the transformers and distributing mains is greater than that of the feeder, while the sum of the maximum demands of the feeders is greater than that of the substation, and the total of the substation maxima greater than that of the main generating station.

The ratio of the sum of the individual maximum demands of the distribution system to its actual maximum demand at the place of supply is called diversity factor—that is, if the sum of the individual maximum load on the feeders is 700 kw. and the corresponding maximum of the feeder is 600 kw., the diversity factor is $700 \div 600 = 1.17$.

By improving the diversity factor the station is operated more efficiently, as the demands upon the distributing system vary definitely throughout the year, depending upon the pratices and habits of the community served, and also upon the character of the service. The changing characteristics of these conditions are easily determined by a careful study of the load curve. Therefore the importance of the diversity factor, together with good service, is three-fold: (1) It is possible to meet the requirements of a varied number of consumers with a considerably smaller investment, as it is not necessary to increase the generating capacity. (2) It results in a lower cost of production, because, by the proper distribution of these demands, the generating units may be operated at their most efficient point the greater part of the time, with a coincident reduction in cost of labor and fuel per kilowatt hour. (3) It improves the station load-factor, as it decreases the peak load without affecting materially the average load.

In order to determine the possibilities of any specific situation, we should first consult a map showing the location of the surrounding country and the towns that are not electrically served, pick out a group of such towns within a radius of say fifteen miles from the town most advantageously situated for a center of distribution, then ascertain the characteristics of the towns within this group, get the bank ratings and deposits, and the ratings of the leading industries and business men in the town. Next, study the topography, which will show whether or not there are any serious difficulties to be overcome in the construction of transmission lines. Last, look to the railway facilities.

In estimating the total cost of the main station, there are many variable factors, all of which will not fit every locality, and therefore we must presuppose certain conditions based on averages. Exact values, for the locality under consideration, should be substituted for general figures wherever possible. The most important items to be considered in locating the main generating stations are: (1) The method of driving the generators. (2) Location, with respect to (a) fuel supply, (b) pure water supply, (c) railroad facilities, (d) sufficient ground for growth, (e) distribution. On account of natural conditions, the majority of main stations will probably require a steam unit as prime mover, and therefore this paper will deal only with a steam-operated main station.

In determining the cost of the plant, it is, of course, understood that the total population served, including all towns, such as A, B, C, D and E, is about 6,000, which will necessitate the installation of 400 kilowatts in order to meet the peak demands. Because of the distances and class of service, it will be necessary to use alternating-current, 3-phase, 60-cycle distribution, transmitting the power at the highest voltage possible, depending upon the initial investment, the distances to be covered, and the losses involved. For distances not exceeding fifteen miles, 13,200 volts is recommended, and the transmission line should consist of No. 4 B. & S. hard-drawn bare copper wire, or possibly No. 6 B. & S. may be used economically.

The total cost of such a plant installed in a town of 3,000 inhabitants and meeting the requirements under consideration would be:

Land	$600	
Brick building	3,000	
Concrete chimney	1.450	
Legal and franchise expenses	200	
		$5,250
3 200-hp. hand-fired return tubular type boilers	$11,100	
3 boiler feed pumps	500	
1 feedwater heater	500	
		12,100
2 non-condensing turbo-generator sets with direct-connected exciters, total capacity 300 kilowatts	$10,500	
1 5-kw. motor-driven exciter set	350	
1 controlling switchboard	600	
1 20-kw. constant-current transformer and panel.	390	
1 transformer for station lighting	50	
3 step-up transformers for transmission	900	
		12.790
3 miles of poles with pins, insulators, etc	$1,800	
10 miles No. 4 B. & S. bare copper wire	3,400	
10 miles 5-kw. transformers for secondary system.	370	
35 6-6-ampere flaming arc lamps	1,300	
150 100-watt tungsten lamps	150	
150 brackets and sockets	520	
270 house meters	1,800	
		9,710
Installation of complete equipment	$3,000	
Add for contingencies	1,000	
		4.850
Total investment for power plant		$43,850

EXPENSES

Fixed charges		
Interest, 5%	$2,190	
Depreciation, 8%	3,500	
Insurance and taxes, 1%	219	
		$5,909
Plant operating charges		
Fuel	$3,500	
Oil, waste, etc	100	
Water	200	
Wages, operators (four)	3,000	
		6,800
Office expenses		
1 bookkeeper and stenographer	$800	
1 electrician and helper	1,500	
stamps, stationery etc	100	
1 general manager or chief engineer	1,800	
		4,200
Maintenance		
Repairs to buildings	$100	
" " steam plant	200	
" " electric plant	100	
" " distribution system	400	
Miscellaneous supplies	200	
		1,000
Total operating expense of plant		$17,909

For each of the smaller towns—that is, B, C, D, E and F—it is proposed to distribute the power from a cheap substation, the cost of which will vary greatly, depending upon its location and the material used in construction, but for the majority of cases the cost of the substation should not exceed $4,000, including distribution system and the following equipment:

Item No. 1 Necessary poles, with their steps, cross-arms, pins, insulators, etc., for transmitting power from main station to each of the substations.
" 2 1 step-down transformer.
" 3 1 aluminum-cell lightning arrester and choke coils.
" 4 1 constant-current transformer.
" 5 1 controlling switchboard.
" 6 series arc lamps.
" 7 series incandescent lamps.
" 8 house meters.

The average cost of this material would be:

Item No. 1 From $7.00 to $8.00 per pole.
" 2 $7.50 per kilowatt.
" 3 $165 per substation.
" 4 $16.20 per kilowatt.
" 5 $3.50 per kilowatt.
" 6 $80 per kilowatt of lamps.
" 7 $10 per kilowatt of lamps.
" 8 $6.65 each.

It will be interesting to note, for comparative purposes, that the average cost of a substation, with its equipment and distribution system for five towns varying in population from 300 to 3,500 inhabitants, and averaging about twelve miles from the center of distribution, was $4,400. The most expensive installation being about $7,000 and the least expensive about $1,500. These figures include all labor.

After arriving at the cost of a complete installation, it will not be difficult to determine, following a careful survey of the town under consideration, whether or not it will be a paying proposition. The rates secured for service of this character are usually not less than $70 per year per arc lamp for all-night moonlight service, and $25 per year for 100-watt series tungsten lamp on the basis of an all-night moonlight schedule, it being understood that the town is to pay for all lamp renewals; for all commercial and house lighting, 15 cents per kilowatt-hour for the first 20 hours, and 12 cents per kilowatt-hour for all current consumed in excess of this amount, with a minimum meter charge of 50 cents per month. For power service the price will vary, depending upon the amount of energy required, but it should be at least 7 cents per kilowatt-hour.

Using the above rates, the following income should be expected from towns of 800 to 1,000 inhabitants:

6	6.6-ampere flaming arc lamps, enclosed type...	$420	
30	100-watt incandescent lamps	750	
15	commercial customers, 6,000 kw.-hr...........	900	
50	residence customers, 6,800 kw.-hr............	1,030	
5	power customers, 800 kw.-hr..................	560	
			$3,660

From a town of 3,000 inhabitants, where the main station is installed, the following income may be expected:

35	arc lamps, $70 per year each	$2,450	
150	100-watt tungsten lamps	3,750	
270	commercial and residence customers, 66,000 kw.-hr	9,900	
28	power customers, 45,000 kw.-hr...............	3,150	
			$19,250

Expenses of each substation		
10% depreciation, insurance and taxes	$440	
5% interest	200	
Repairs to transmission line and equipment	200	
Labor, one man	900	
Line inspection	300	
		2,060

Generating plant expense		
Total operating expenses of generating plant and its distributing system		17,909
Total investment for generating plant $43,850		
Total investment for five substations	22,500	
Investment for entire system		66,350
Total gross income from system	37,500	
Total gross expense, including generating plant and five substations	28,209	
Total net profit from the entire system		$8,291

This shows a profit of 12½ per cent on the entire investment, which compares very favorably with the profits of other important industries, and is borne out in many specific instances of the kind recommended.

APPARATUS REQUIRED.

It is not possible to give a detailed description of all the apparatus needed, but a few suggestions are offered which may be of value. The buildings should be constructed of the material best suited to local conditions, due consideration being given to insurance and maintenance. It will often be found for this class of business that a low first cost will not be the cheapest when these items are considered. In an installation of this character and size it will be found desirable to install turbines for non-condensing operation, this being especially true when the central station enters into the steam heating and ice business, as proposed here. There may be exceptions, however, especially where the cost of fuel is high and plenty of water for condensing purposes is available.

The generators recommended for this class of service are the alternating-current type direct-connected to and mounted on the same base with the turbine. A turbine is considered in preference to the reciprocating engine in order to keep down the size of the building and repairs. The alternating-current, 3-phase machine is used in preference to direct-current in order to insure economic distribution. A direct-connected exciter of sufficient capacity to excite each generator is suggested, and a motor-driven exciter set so as to have an extra unit available for emergencies.

The controlling switchboard performs a most important work in the system, as it shows the operator at all times the power generated by each unit and how it is distributed to the feeders. Therefore great care should be exercised in purchasing correct reading instruments, and protective devices which will guarantee the greatest degree of safety.

For distribution the core-type transformer is recommended, together with a cheap compression-chamber type lightning arrester for protection. Good street lighting is recognized as a necessity, since it offers protection at night, stimulates business, and not only adds to the attractiveness, but reflects the progressiveness of the municipality. Therefore the city lighting should be given careful attention, and to meet these requirements both arc and tungsten lamps are used, operating in series on the same circuit. For this service, in order to maintain constant current, a special type of transformer is used, designed so that the secondary coils adjust themselves automatically to maintain a constant current on the lamp circuit.

In an installation of this character reliability of service is of prime importance, and this necessitates the installation of the most efficient and dependable apparatus available. Automatic devices should be installed to reduce the operating expenses, such as time switches in the street lighting circuits and the single-phase automatic pole-type feeder regulator for outdoor service, which makes possible the individual regulation of taps from the main feeder, entirely distinct from the regulation given other parts of the same feeder, thus making it possible to use lamps and transformers of similar voltage throughout the system. By a careful system of inspection, the cost of which should be distributed among the various plants, interruptions in service may be kept to a minimum.

NEW POSSIBILITIES.

Where conditions are proper, it will often be found profitable and economical to operate in conjunction with the central station an ice plant for manufacturing ice during the summer months, and a steam-heating system for heating purposes in the winter, and this necessitates the installation of non-condensing turbines in the main station. In the manufacture of ice, motor-driven machinery can be used which will help out the load-factor during the summer months, and as there is usually a surplus of exhaust steam available the additional cost for the manufacture of ice will not be great. By this system sufficient ice may be manufactured at the center of distribution to supply the demands of the other communities served with electric power.

Ice can usually be economically produced in a plant of this character for not more than $1.50 per ton by the can system, including all reasonable charges, on the basis of a 50-ton plant. In order to keep down operating expenses, arrangements may be made with the local coal dealer to buy ice on a quantity basis, as he is in a position to distribute it with nearly the same equipment that he uses in the winter for the delivery of coal. For manufactured ice the central station should receive on the wholesale basis at least $2.50 per ton, net, at the plant. This would represent a total net earning as follows:

Total cost basis, 50 tons per day for 6 months......	$12,600
Total income basis of $2.50 per ton..............	21,000
Net income	8,400

With regard to steam heating, it is usually maintained that this is not a profitable business, and in view of this, considerable study should be made by the central station before entering the field. However, if reasonable rates can be secured for steam heat, it should be a paying business, or at least the net earnings from this source will usually pay the central station coal bill for the year.

In most localities it is necessary for the municipality to maintain a pumping station to furnish water for the city supply, and this class of service is always an advantageous load, as the water may be pumped into the reservoir during the off-peak period of the day or night.

Another interesting field for the sale of power which is just beginning to receive attention is that for general use about the farm, where it can be economically applied to more than 100 farm and household uses. Distribution lines can be tapped at little expense for this service.

Characteristics of Alternating Current Circuits

BY A. H. TIMMERMAN.

A Discussion of the Relationship of Resistance, Reactance, and Impedance, Leading and Lagging Currents and Apparent and Actual Power in the Alternating Current Circuit.

THE simplicity of the relation $I = E \div R$ and its application to the direct current circuit, has a tendency to impress upon those less familiar with relations in the alternating current circuit, the apparent complexity of such terms as leading and lagging currents, apparent and actual power, resistance, reactance and impedance, so frequently mentioned in discussing alternating current relations. Yet these qualities are after all comparatively simple, when once their relationship has been firmly fixed in the mind and the characteristics of the alternating current circuit become as simple as the corresponding characteristics of the direct current circuit. In what follows a simple discussion of the relations in the alternating current circuit is given by A. H. Timmerman, chief engineer of the Wagner Electric and Mfg. Co., taken from a paper he presented before a body of sales engineers at St. Louis, Mo.

As a rule our knowledge of direct current circuits is limited to the relations between current, electromotive force and resistance after the current has reached a steady or fixed value. In ordinary discussions we entirely overlook what takes place when a direct electromotive force is suddenly introduced into the circuit. We forget for instance that when the circuit includes a coil of wire with an iron core, we have to store up energy in the magnetic field of the coil. When we take into consideration the fact that we cannot store up any quantity of energy instantaneously without the use of infinite power, we at once begin to realize that the current in such a circuit must lag behind the electromotive force which produces it. In other words, if we have a circuit consisting of a resistance of one ohm, this resistance being wound in a coil and an iron core inserted, we would have, after normal conditions were reached, a steady current of 100 amperes if the electromotive force introduced was 100 volts. From the fact, however, that energy must first be stored up in the magnetic field, and that this energy increases with the current it can readily be seen that as the current increases in value it stores up more and more energy in the magnetic field, and that in turn the magnetic field tends to prevent the current from increasing in value. In the same way the energy stored up in the rubber of a pneumatic tire tends to prevent the increase of air in the tire although forced by considerable pressure from an air pump.

This lagging of the current behind the electromotive force is shown clearly in Fig. 1. Current in amperes is plotted along the vertical, and time in fractions of a second along the horizontal, and it should be noted that it requires a very appreciable interval of time for the current to reach its maximum value. In the particular case shown the current reaches 99.99% of its maximum value in one second. Theoretically it would require an infinite time to reach its maximum value. In 1/10 of a second it has reached about 63% of its maximum value, in .2 of a second 86% and so on. As long as no changes occur in the resistance of the circuit the current will flow along at a steady value of 100 amperes.

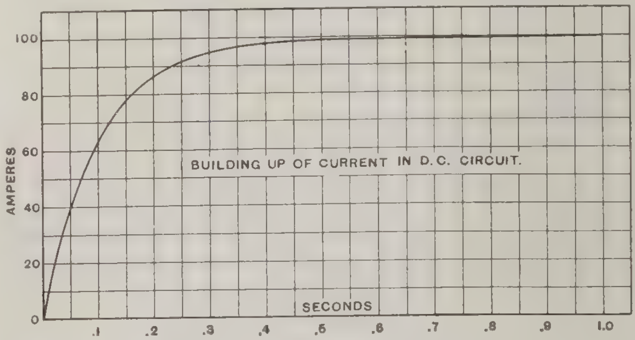


FIG. 1. BUILDING UP OF CURRENT IN A D. C. CIRCUIT.

Suppose, however, that the electromotive force is suddenly removed, or in other words, the circuit broken. Under these conditions the tendency is of course for the current to die out. If it were not for the energy stored up in the magnetic field the current would die out instantaneously. As the current drops, however, the magnetic field gives up its energy; in other words, has a tendency to return to the circuit the energy stored up, with the result that the current does not die out instantaneously, but decreases gradually as shown in Fig. 2, reaching a final or zero value in infinite time. Practically, however, for the case shown, the current would drop to .05 of 1% in one second. The restoration of the energy of the circuit in the case above referred to can be shown by the simple experiment of connecting across the shunt field of a direct current generator or motor, an incandescent lamp. When the circuit furnishing current to the

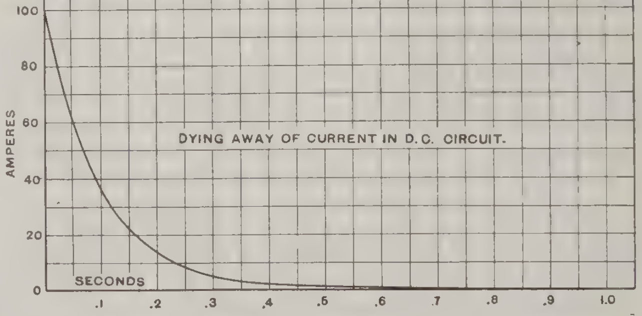


FIG. 2. DYING OUT OF CURRENT IN A D. C. CIRCUIT.

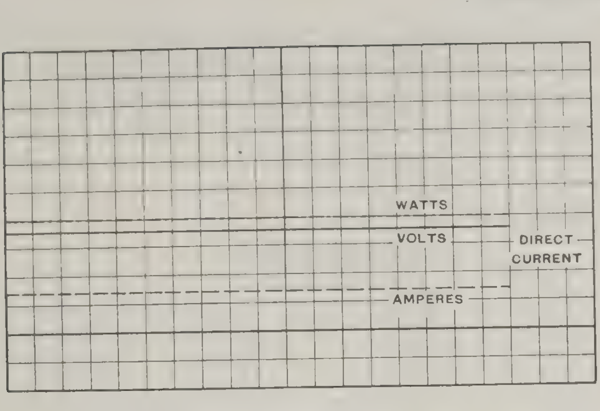


FIG. 3. CURRENT, ELECTROMOTIVE FORCE AND POWER IN A D. C. CIRCUIT.

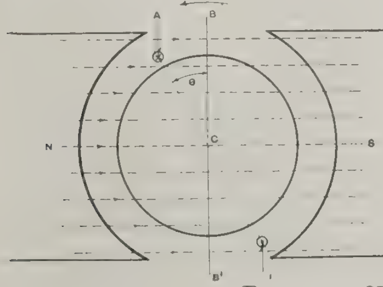
shunt field is interrupted, the lamp will glow or perhaps burn brightly, depending upon the voltage due to the discharge of the magnetic field. If no path is offered for the discharge of this energy, an abnormal rise in voltage is the result and in many cases the insulation of the field destroyed, due to puncture by the high voltage developed.

We have then in the direct current circuit a lagging of the current behind the electromotive force in the same way that we have a similar lagging behind the electromotive force in the alternating current circuit. As remarked in opening, these are phenomena which are ordinarily overlooked in the discussion of direct current circuits and are apt to lead us to the conclusion that the phenomena of the alternating current circuits are, therefore, very much more complex.

If a direct current circuit is continually made and broken with an ordinary interrupter, such as is used on an induction coil, the current curve would be made up of a number of curves as shown in Figs. 1 and 2, placed one after another. If the interrupter broke the circuit every tenth of a second, the current would never be able to reach more than 0.63 of the maximum value which would be reached if the circuit were undisturbed after once being closed.

The curves discussed above have been plotted with a value of the resistance of one ohm and a co-efficient of self-induction of .1 of a henry. With other values of the resistance or co-efficient of self-induction, the curves discussed would vary somewhat in shape but their characteristics would be similar. These steady conditions of current, electromotive force and power in the circuit are shown in Fig. 3, in which time is plotted along the horizontal axis.

The earliest forms of generator were of the alternating current type, for the reason that this is the simplest type of machine to build. It consists essentially of a single coil of wire or a number of coils connected in series, revolving in a magnetic field, as shown in Fig. 4. A A′ shows a coil of wire revolving counter clock-wise in the magnetic field set up between the pole pieces N and S. When this coil is in the position B B′, it is moving at that particular instant of time parallel to the direction of the magnetic field, and as the electromotive force generated is proportional to the rate of cutting through the magnetic field, the electromotive force set up at this time will be zero. As the coil revolves the electromotive force set up is increased until the coil is in a horizontal position at which time it is moving at right angles across the field, and the electromotive force is a maximum. As the coils continue to revolve, the rate of cutting through the magnetic field becomes smaller and smaller until the position B′ B is reached, at which time the electromotive force generated is again reduced to zero. As A moves upward through the magnetic field (in continuing its revolution) it begins to cut through the magnetic field in the reversed direction and the electromotive force set up is also reversed in direction. Continuing the revolution, the electromotive force reaches a maximum in the horizontal position, and is then gradually reduced until B B′ is reached.



e = E SIN φ

E = MAXIMUM VALUE OF E M F 50

φ	SIN φ	E SIN φ
0	0.000	0
30	0.500	25
45	0.707	35
60	0.867	43
90	1.000	50
120	0.867	43
135	0.707	35
150	0.500	25
180	0.000	0

FIG. 4. ESSENTIAL PRINCIPLE OF A. C. GENERATOR.

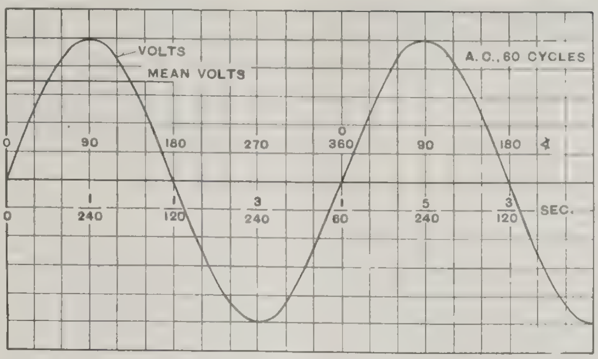


FIG. 5. ELECTROMOTIVE FORCE CURVE RESULTING FROM REVOLVING COIL OF FIG. 4 IN A MAGNETIC FIELD.

If we represent by Θ the angular position of the revolving coil with respect to the line B B′ the electromotive force set up may be represented by the equation

$$e = E \sin \Theta$$

in which e is the instantaneous value of the electromotive force generated, and E the maximum value which it will reach.

If we plot electromotive force along the vertical, and angular position of the coil along the horizontal, the resulting electromotive force curve is shown in Fig. 5. If the coil revolves so as to make 60 complete revolutions per second, we say that the electromotive force set up is a 60-cycle e.m.f. We can then plot the horizontal scale as so many seconds, or fractions of a second as well as in degrees. As the coil revolves through one complete revolution, its change in electromotive force is represented by the curve between the points of zero and 360 degrees, or zero and 1/60 of a second. It should be noted that during this interval of time the electromotive force has gone through one complete cycle, or two alternations. In other words, the electromotive force has reversed twice during this period of 1/60 of a second. One cycle per second equals two alternations per second. 60 cycles per second or, as we ordinarily call it, 60 cycles is, therefore, equal to 7,200 alternations per minute, or as usually called 7,200 alternations.

The question now arises as to the indication of a voltmeter connected across such a circuit. Will a voltmeter read the maximum value or the minimum reached, or some other quantity? Voltmeters are so constructed as to read the mean value of the electromotive force wave during ½ a cycle. If the maximum value is 100 volts, the mean value during the ½ cycle will be 70.7 volts. If, on the other hand, the voltmeter indicates 100 volts, it means that twice during each cycle the voltage reaches an actual instantaneous value of 141 volts. In other words, the relation between the mean and maximum values of the voltage is as 1 is to 1.41, or as 0.707 is to 1. In a 25 cycle circuit the voltage goes through one complete cycle every 1/25 of a second, or alternates in value every 50th of a second, while in a 60 cycle circuit the electromotive force alternates every 1/120 of a second. These time intervals are exceedingly short. You can, therefore readily see how in an alternating current circuit containing a magnetic field, the current will lag considerably behind the electromotive force and how its maximum value will be very much restricted below the corresponding maximum value reached in the direct current circuit. As in a direct current circuit containing resistance only the current does not lag behind the electromotive force, but reaches its maximum value the moment the electromotive force is introduced, so in the alternating current circuit the current reaches its zero and maximum values at the same time that the electromotive force reaches its zero and maximum values.

Under such conditions, namely, that of resistance only, and no magnetic field, the maximum value which the current reaches will be the same as that in a direct current circuit. The values of the electromotive force and resistance being the same in the two cases.

In Fig. 6 are shown the current and the electromotive force for a circuit containing resistance only. It should be noted that the current fluctuates with the electromotive force, and is proportional to it at all times. This then is equivalent to the direct current circuit containing resistance, but no magnetic field in which energy can be stored up.

Let us next imagine a circuit containing a magnetic field which is produced by a number of turns of wire around an iron core and assume that the wire is so large in cross-section that its resistance is zero. Practically this is impossible, but we can nevertheless approach very nearly to this condition. Another way of describing a circuit of this kind is to state that it contains reactance only, and it should be carefully noted that this reactance reduces the flow of current in the same way that resistance limits the flow. In other words, in an alternating current circuit with absolutely zero ohmic resistance between the two leads the current would not reach an infinite value if there were reactance in the circuit.

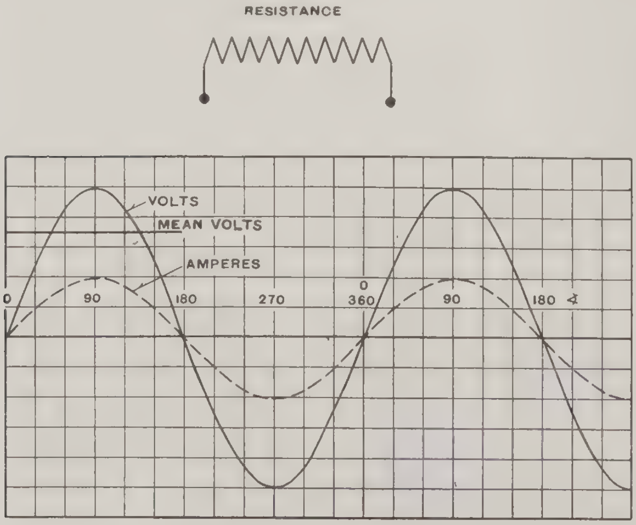


Fig. 6. Current and Electromotive Force Curves for a Circuit Containing Resistance Only.

A little further along in the discussion we shall find that under these conditions there is no energy lost in the circuit such as is caused by an ohmic resistance. We can then by means of a reactance limit the flow of current in an alternating current circuit, even although no resistance is present.

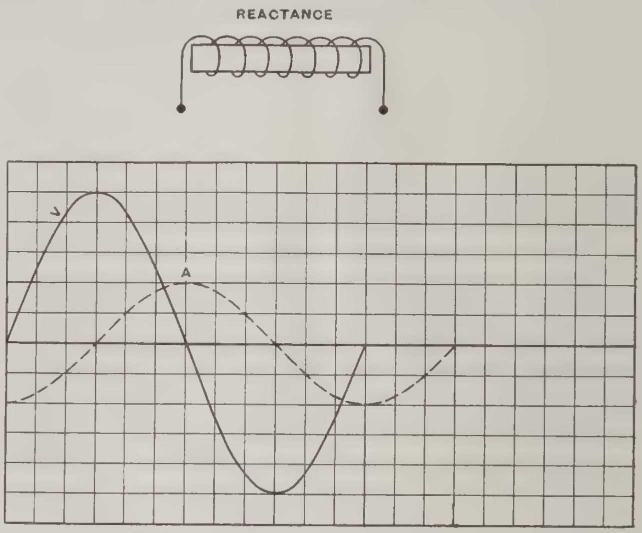


Fig. 7. Current and Electromotive Force Curves for a Circuit Containing Reactance.

In such a circuit the current will be zero when the electromotive force is a maximum, and the current will be a maximum when the electromotive force is a zero. In other words, the current lags behind the e.m.f. by an angle of 90 degrees, or in a 60 cycle circuit by 1/240 of a second. This relation is shown nicely in Fig. 7.

The next section of this article will continue this subject, taking up other relations.

Electric Lighting in Manchuria.

The South Manchuria Railway maintains electric lighting plants at Darien, Mukden, Changchun, Antung and Liaoyang, and holds a controlling interest in the lighting plant at Newchwang, which is operated in connection with the waterworks establishment at that port. All of these institutions seem to be giving fair business returns. Supplementary equipment, increasing the capacity by 1,500 kilowatts, has recently been added to the Dairen plant. The capacity of the lighting establishments at Antung and Changchun is also being increased, and an additional generator will be installed at the Liaoyang plant in the near future. The construction of an electric tramway and the enlargement of the railway lighting plant at Mukden are under discussion, but negotiations with the Chinese authorities have made little headway.

Recent statistics of lighting plants located at main points along the railway give the number of households in which current has been installed as follows: Dairen, 6,600; Mukden, 1,200; Changchun, 1,200; and Antung, 1,250. Meters are installed only where five or more lamps are in use, and the figures show that 32,000 lamps are supplied by meter in Dairen, 2,300 at Mukden, 3,400 at Changchun and 2600 at Antung. Lamps supplied by monthly contract number 16,000 at Dairen, 4,500 at Mukden, 3,800 at Changchun and 3,600 at Antung.—*Consular and Trade Reports.*

Important Considerations When Ordering Power Transformers

(*Contributed Exclusively to Electrical Engineering*).

BY H. G. DAVIS.

Section 4. Discussion of Types of Transformers.

AFTER the size and capacity of transformers have been determined from the considerations given above, the type of construction or method of cooling should be determined. There are three general types named from their method of cooling. These are (1) oil cooled, (2) air cooled and (3) water cooled transformers.

Oil Cooled Transformers. By an oil-cooled transformer is meant one that depends on oil chiefly as cooling medium. This oil which serves as the cooling medium also serves as an insulating medium wherever it is used. In the so-called water-cooled type, oil is the insulating medium and also the secondary cooling medium. There are two classes of real oil cooled transformers—oil-insulated, self-cooled transformers and forced oil-cooled. The first class includes almost all distribution transformers of the outdoor or pole type. These transformers are either of core type or the shell type and have the windings and core immersed in the oil in the transformer tank. The oil fills all spaces and ducts in the core and windings and helps the insulation. When the windings and iron core are heated by the losses, the oil is also heated and the hottest portion rises to the top. The oil coming into contact with the air at the surface and with the transformer tank gives off its heat. Thus a continual circulation is obtained and an effective cooling medium is supplied. Since oil is the heat circulating medium only and the real heat dissipation is at the surface of the tank, the type of tank has to be considered. Since the capacity of a transformer increases faster than its surface area, the cooling surface does not increase as fast as the losses which have to be dissipated. Thus the exposed tank surface must be increased. This is done in various ways. A plain surface tank is most efficient per unit area. However, the smooth surface tank must be confined to the transformers of small capacities and low losses or else the tank would be prohibitively large and hence costly. Various methods have been used to increase the radiating surface of the tanks without too greatly increasing the size. These are the smooth surface, the ribbed surface and the corrugated surface with a fourth method being external jacket or tubes. As stated above, smooth surface tanks are suitable for low losses only. Cast iron tanks for this type will radiate more heat than rolled iron plate. The ribs when applied to a smooth tank increase the radiating surface as they conduct heat to the surface and increase the surface exposed to the air. However, the most generally used method is that of corrugating the surface. Many forms of corrugations are used and as the losses increase self-cooled oil insulated transformers require tanks with complicated surfaces or else the external tubes are adapted.

While the cooling for a given shape of tank is affected by the material, the paint on a tank will also have a certain effect. Tests have been made using black paint, white enamel and aluminum paint. These tests indicated that the white enamel or aluminum paint caused the transformers to run several degrees cooler during the day, but warmer at night. Since the load for most distributing transformers comes on at night, the value of the white enamel paint is questionable. This shows, however, how the conditions of operation will affect heat dissipation from transformer tanks.

Using the cost basis for the different type of tanks, the rank from the standpoint of minimum cost for a given heat dissipation with an equal oil temperature rise is (1) corrugated steel tank, (2) corrugated cast iron, (3) plain boiler plate, (4) plain cast iron tank. The cost of the corrugated steel tank to dissipate a given loss with a certain rise in temperature is only about 60 per cent of the cost of a plain cast iron tank. These are simply relative values of tank cost alone.

The second class of oil cooled transformers is the forced oil type. In this type the oil serves as an insulating medium and at the same time takes the heat from the windings and allows a certain amount of heat to be radiated from the tank surface. The real method of dissipating the heat is by circulating the heated oil from the top oil surface through cooling coils and back again to the transformer. This requires an oil pump and an external cooling coil with a cooling medium. Thus the transformer requires an outside or auxiliary cooling medium and could not be called self-cooled. The cooling equipment is a part of the transformer cost and the motor pump is part of the transformer losses. The oil itself is circulated through a cooling medium by taking the hot oil from near the surface and returning it after cooling to a point near the bottom of the tank.

Water Cooled Transformers: The so-called water cooled transformers are oil immersed as in the self-cooled oil insulated type. However, the cooling of the transformer by radiation and convection of the heat from the tank surface is only a secondary effect. The chief or main cooling is by the water circulating through cooling coils inside the transformer case. These coils are located near the surface of the oil, which is the hottest part. The oil in the case circulates through the ducts in the core and between the coil layers. The heat reaches the oil by conduction and is dissipated by convection and radiation by the water flowing in the cooling coils. Thus the amount of cooling by air currents from the tank is negligable and the water is the cooling medium. For a given temperature rise the transformer tank can be made much smaller than the tank of a self-cooled transformer and floor space can be saved, but the necessary equipment for water circulation must be supplied and if water is costly, the cooling medium becomes a source of expense. The reduction in floor space due to tank size is offset by the additional equipment required for cooling. In very large units self-cooling is out of consideration.

Air Cooled Transformers: This type of transformer depends entirely upon air currents in direct contact with the windings and core. Thus the oil insulating qualities available in the self-cooled and water-cooled types can not be used and additional insulation on the coils is required. To allow for access of air large ducts are required. Thus the voltages are limited for this type of transformer and for high voltages the water-cooled transformer with its oil insulation advantages is required.

The method of cooling requires a forced draught which is obtained by the use of a blower. This type will thus require additional equipment for cooling which is properly a part of the transformer cost. The installation must be made so that the forced air is circulated through the windings. This is usually forced from the bottom of the transformer upward and out at the top. Dampers are provided so that the air circulation can be regulated. The blower equipment as installed should have cool air for the intake and yet dampness should be prevented as this will cause failure of the insulation in time.

The transformers as given are cooled by the following steps: In the oil insulated self-cooled, the heat is dissipated by conduction through the insulation, convection and radiation through the oil and convection and radiation from the tank to the air. In the forced oil cooled, the heat is dissipated by conduction through the insulation, convection and radiation through the oil to the tank (this is a minor portion) and by convection and radiation from the external cooling coils. In the water-cooled, the dissipation is the same as in the forced oil type, except that the major portion of the heat is dissipated by convection from the water circulated in the internal cooling coils. In the air blast transformers, the cooling in this type is dependent only on conduction to the circulating air.

In considering the different types, provisions should be made for cooling and an ample supply of the cooling medium should be available. Self-cooled oil insulated transformers of a given size will require a larger floor space than a water-cooled transformer. Thus in building for a transformer installation where space is cheap it would be out of the question to install a pump for circulating water to the water-cooled type unless high voltage and large capacity requires the latter type. Self-cooled transformers when housed should have free access to air. This can be seen when we consider that one kilowatt loss per minute will raise 1650 cubic feet of air one degree Centigrade. Thus allowing a ten degree rise in the air due to transformer losses each kilowatt of loss would require 165 cubic feet of air per minute. Assume a transformer of 1000 kilowatt capacity at 98 per cent efficiency. This means a loss of 20 kilowatts and would require 3300 cubic feet of air per minute. A room 20 x 10 x 15 feet would require that the air be renewed once every minute unless an undue temperature rise result. Thus the room for housing self-cooled transformers should be well ventilated or have artificial air circulation.

The water-cooled type does not require as much floor space as the oil insulated self-cooled type. However, the supply of cooling water must be considered and the method of circulating the water. In water power installations the head of water supplies the pressure required and the water required for the cooling is naturally taken from the penstocks supply. Where substations or steam stations have this type of transformer, pumping the water must be considered and provisions made for the supply. The cost of the water if supplied from city mains should be considered with the auxiliary equipment required as balanced against the additional building and floor space required for the self-cooled type. An estimate of the water required for cooling the transformer can be made if the losses are known approximately. Thus allowing a ten degree rise in the cooling water, one gallon of water per minute is required for each 2650 watts loss. This is not allowing for the slight cooling that takes place from the tank. The room for the transformer of this type can be made of just the proper size to give clearance for handling the transformer and safe distances for high tension leads.

In considering air blast transformers the equipment of blower and driving motor can be considered by an approximation of the losses. It is customary to allow about 150 cubic feet of air per minute for each kilowatt loss in the transformer. Knowing the approximate losses, the size of the blower can be determined. The air is usually supplied at the bottom and the warm air led from the top. The air intake should be cool air and not hot air from an engine room or boiler room. Transformers of this type are not used for very high voltages or in very large units.

The above types and auxiliary equipment are to be considered in ordering a transformer. The facts as mentioned enter when considering an indoor installation. Where space is available and also from the standpoint of lower cost an outdoor installation could be considered.

TRANSFORMERS FOR OUTDOOR INSTALLATIONS.

For an outdoor installation, the oil insulated self-cooled transformer is most satisfactory as it requires no auxiliary cooling apparatus and the least attention in service. Since very large self-cooled units placed indoors require a large room and an abundant supply of air, the advantage might be with an outdoor installation. The danger of the oil freezing could be minimized by an auxiliary heating apparatus under the tank for heating at times when the transformer is not in service. The oil too has a low freezing point and there are some grades that do not freeze as low as minus 40° C.

The point most considered in connection with transformer for outdoor service is that of moisture. Distribution and pole type transformers have been installed outdoors and the results show that moisture is not to be feared as much as would be considered at first thought. These transformers have not been made moisture proof or air tight and yet tests of oil from transformers that have been in service for several years have shown that very little if any moisture has entered. Indoor installations have shown worse conditions due to moisture inside the case. These installations have been made by having the transformer case not air tight and yet not having free breathing space. This condition results in a change of temperature without a corresponding pressure change. Since air indoors is most often of greater humidity than that outdoors, a lowering of temperature inside the transformer without a free access of air will probably result in condensation. This is perhaps the reason that pole type transformers having free breathing space in the gasket between cover and tank have not suffered from this trouble. Thus with a provision for protection against mist and rain and with proper breathing space arranged, the transformer outdoors has very little chance of condensation of moisture in the cover as the atmospheric conditions have free changes in pressure and temperature.

Water-cooled transformers for outdoor installations require that a slightly different arrangement be made for the water piping so that freezing will not result. The pipe supplying the cooling water should be protected by some covering if run above ground. The water piping could be run underground to the transformer and the coil terminals could be brought out at the bottom of the transformer. The piping should also be laid so that it can be drained when the transformer is not in operation. This is the critical time as regards freezing, but the transformer would not often be idle unless a spare unit is installed.

Air blast transformers can be used in an outdoor installation provided that rain is kept from the windings. The effect would not be serious, however, for with the higher temperature of the air the capacity for moisture is greatly increased and the small amount of rain that might enter would be absorbed and carried away. The blower intake and the discharge from the transformer could easily be constructed so as to prevent the entrance of rain into the windings. The question of freezing would not have to be considered in connection with air blast transformers.

In any outdoor installation the question of preventing the transformers from absorbing heat from the sun could be solved by using some heat insulating material in the form of a cylinder around the transformer. This would not be costly and the chimney effect of the cylinder would increase the cooling. Sheet metal is effective for this purpose and can be made more so if it is painted white on the side next to the transformer.

Some Problems Met and Solved By an Electrical Trouble Man.

(Contributed Exclusively to Electrical Engineering.)

BY J. A. HORTON.

Section 2. Causes and Solutions of Various Troubles in A. C. Apparatus.

INDUCTION motor heating causes are of two general classes: Those that do not unbalance the phase currents and those that do. Of the first kind, perhaps the most common is overload. Knowing the work that an induction motor must do, it is customary to select a size that will run near its rated load when doing normal duty, because at light loads the power-factor is low. If, therefore, the mechanical load is afterward increased, as it often is, the motor becomes overloaded. The torque of an induction motor is proportional to the square of the applied voltage, and, therefore, decreases rapidly with it. A decrease in torque slows the rotor and increases the rotor slip, thereby letting in a larger current to produce increased heating. Another common cause of heating is bearing wear, which lets the rotor rub the stator. The rotor surface gets very hot from mechanical friction incident to the rubbing, and this heat, rapidly conducted, soon heats the whole machine. Furthermore, the added load due to the friction increases the slip and current, and as heating increases as the square of the current, heat increase may be very rapid. A fourth cause of heating is low frequency, due, perhaps, to an engine or to a water wheel running below normal speed, or to the motor itself being of the wrong frequency for the service lines. High frequency apparatus heats when operated on lower frequency, because the current reaches higher values before reversing. Excessive voltage heats an induction motor for the same reason that it heats any piece of electrical apparatus. It produces a proportionally larger current.

Among the causes that increase the heating and at the same time cause unbalancing of the currents, in the two or more phases, are: Unbalanced voltage, due to short-circuit within the motor; to short-circuit in another device operating from the same service; to partial short-circuit on the line or to unbalancing of the supply voltage, on account of unbalanced loads on the generator. In any of these cases, however, a voltmeter will show the unbalanced voltage condition, and ammeters cut into the motor service wires will show the unbalanced currents. Finally, a polyphase motor will heat if operated single-phase, especially if its mechanical duty calls for an electrical output which is near the motor's normal rating. Of course, a polyphase motor cannot start single-phase; but there are conditions under which the starting circuit may be intact and the running circuit include a break. For example: A motor started from a compensator may come up to practically synchronism on the starting side of the compensator, and when the compensator is thrown over to the running side the load may be insufficient to break the motor down, even with an open circuit in the running connections. In such a case the motor will continue to run, but as a single-phase motor. The same thing occurs where a motor is operated from a controller the cylinder of which may be eccentric or the cylinder bearing of which may be loose. In either case all fingers may make contact on the starting notches and one finger fail to contact on the running positions.

Induction Motor Air Gap.

Operators accustomed to dealing with air gaps measured in sixteenths and eighths of an inch, as in the cases of direct current machines, sometimes take undue liberties with air gaps measured in thousandths of an inch, as in the case of induction motors, especially in the smaller sizes. In two instances, quite close together, have inspectors been called in on account of excessive heating due to rotors having been turned off, only "a hair," in order to give more clearance and thereby to make the bearings last longer. In the first instance, two similar motors operated a monorail crane, and one of the motors seemed to be doing all of the work, while the "loafer" was doing all of the heating. The ammeters showed that the hot motor was taking twice as much current as the cool one, and, on interchanging rotors, the high current followed the guilty rotor. The crane owner then told the inspector all about it.

In the second instance, four cranes were involved in stator trouble, and it was significant that each crane had

had the same stator trouble. The meters showed that three out of the four cranes were taking normal current, but that the current of the fourth crane was about three times normal. Interchange of rotors again located the defective one. It seems that one crane gave rubbing trouble. Its rotor was replaced with a spare that had been turned down a little as a precaution against future rubbing. In course of time this spare and another rotor that had been similarly treated found their way into every stator on the job and made necessary their rewinding.

Sporadic Troubles.

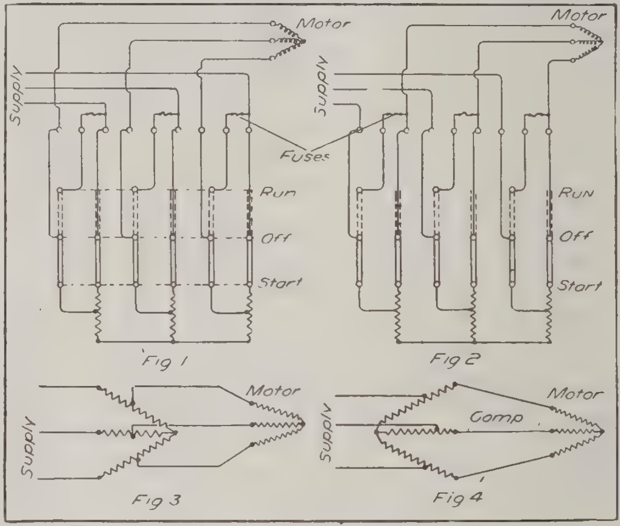
The most annoying trouble is that which manifests itself only at intervals. When one qualified to locate it is available, everything is regular. As soon as help is out of sight, the "bug" again asserts itself. In one case a 20 horsepower, 3-phase rotating resistance type of induction motor would get hot on some half days and would run normally cool on others. An inspector tested it with the instruments and it tested "o. k.," but started to heat again the day after. The motor was on such urgent work night and day that it was not decided to disassemble it for inspection until the operator was badly scared by occasional sparks inside of the rotor. Inspection then showed that all of the trouble had been due to blisters on the internal resistance. The blisters interfered with the short-circuiting contacts in such a manner as to give the impression that the short-circuiting device was all the way in, when it was not. The resistance that remained cut in heated, and the heat was conducted to the frame. It was afterward noted that each time the motor gave trouble after it had been started by a green man who was timid about shoving the switch lever home. To complicate symptoms, sometimes the motor would not start at all. Inspection showed that the oil switch toggle was loose, so that if the switch was closed with a strong impulse, the toggle would release and the switch would then be open without the operator knowing it. This condition often set the operator to looking for serious trouble, when there was none. If the no-voltage release had been connected on the motor side, its buzz would have been a tell-tale.

No-Voltage Releases.

Whether used on an oil switch or on a starting compensator, the object of a no-voltage release device is to insure that the oil switch or the compensator may open should the line become dead. Otherwise a sudden return of voltage to the line is liable to send through the working circuit a current rush likely to injure an operating device. Considering the importance of the release, the extent to which it is neglected is surprising, and especially so when the difference between working and not working is represented by the need of a little oil or emery cloth. Many times inspectors have been called in to fix a release inoperative for want of ten minutes' attention from the operator. As many times has expert help been sought because the release coil was heating. In most cases the heating found would not be dangerous, and would be due to having the coil connected in on the line wires instead of on the motor wires. In the first case, the coil is energized whenever the line switch is in, and in the second case the release coil takes current only when the motor is running. The temptation to connect the coil on the line side of the starter is due to the fact that the buzz emitted when the current is turned on at a distant point serves as a signal that the line is alive. Aside from the useless heating, which in time may deteriorate the insulation in hot climates, there is no objection to this connection where only two or three starters are concerned; but where a mill has 100 or more starters, continuous current flow through the release coils may represent an energy loss well worth considering.

Compensator Heating.

The chances of connecting a starting compensator wrong externally, are small, owing to the manner of bringing out the leads and marking them. Nevertheless, in one case where an inspector was called in to locate the causes of a compensator's heating and of the connected motor's starting with great impulse and heating, interchanged connections proved to be the cause. The line leads and the motor wires had been interchanged at the compensator. The abuse to which motor and compensator were subjected, as the result of the interchange, may be seen by considering Figs. 1 to 4, inclusive. Fig. 1 shows the correct internal and external connections of a 3-phase compensator controlling a 3-phase motor. Fig. 3 shows the simplified connections corresponding to the full line or starting position indicated in Fig. 1. In both figures it may be seen that the line wires connect to the extreme outside ends of the compensator coils and that the motor wires are tapped in at intermediate points, so that the voltage applied to the motor is less than the voltage of the line. When the compensator cylinder is thrown to the running position, dotted position (Fig. 1), the compensator coils are cut out entirely and the motor is connected directly across the line wires. Also each of the line wires then includes a fuse.



FIGS. 1 TO 4. COMPENSATOR CONNECTIONS.

In Fig. 2 the line and motor wires are shown to have been interchanged, and with the result indicated diametrically in Fig. 4. Here it may be seen that the line wires connect to intermediate points on the compensator coils, and that the motor wires connect to the extreme outside ends of the coils, so that the line voltage is increased before it is applied to the motor; and it is increased as many times as the total number of turns in the compensator is times the number of turns spanned by the line wires. It is no wonder that the compensator heated and that the motor also heated, jumped and tended to come loose from its connected load. The starting current of an induction motor may be several times as large as rated full load current, so that a fuse that would protect the motor from ordinary overloads would blow under ordinary starting conditions if it were in the starting circuit. Accordingly, it is customary to cut the fuses into the running circuit, as indicated in Figs. 1 and 2, and to leave the starting circuit unfused.

Coal Handling.

An inspector out west was called in on account of excessive heating and sparking and flashing at the rings of a three-phase motor operating a conveyor that lifted hard and soft coal from a pit to the storage bin, from which the coal was fed through a chute to locomotive tenders. The conveyor included about sixty buckets, and the "ups" about balanced the "downs" at no load. Immediately under the dump car, and operated from the same motor, was a system of driven rollers that pushed the coal along a slideway into the conveyor buckets. The operator stated that the motor would handle hard coal all right, but it got hot when unloading soft coal, notwithstanding that hard coal is considerably heavier than soft coal. He further stated that an ammeter, applied by the local man, showed that the motor was not overloaded. The ammeter must have been in error or the observations unreliable, because the inspector's two ammeters and voltmeter showed the voltage and current to be balanced in the three phases, but the voltage to drop 25 per cent on maximum load. Handling hard coal, the current remained almost steadily at 8 per cent above the motor's current rating at full load; handling soft coal, the current tended to remain at 63 per cent above normal full-load current, but frequently swung to values 80, 90 and even 100 per cent above normal, the swings being due to the soft coal jamming in the feed slide under the dump car. Hard coal flows freely, and the tests showed that estimates based upon experience in handling hard coal will not apply to soft coal.

Standardization of Public Utilities Service

(Abstract of an address at Atlanta. Ga., Convention of American Society for Advancement of Science, December 13, 1913.)

BY DR. EDWARD B. ROSA, CHIEF PHYSICIST, UNITED STATES BUREAU OF STANDARDS.

PUBLIC UTILITIES are now regarded as of a public character, enjoying a monopoly of the market, but owing a duty to the public, and entitled only to a reasonable return on their investments. This duty to the public consists in rendering safe and adequate service at just and equitable rates. In return, the utility is entitled to protection of its investment, and to such dividends that the stockholders will have no just cause for complaint, and that money may be had whenever necessary for extensions and improvements. Under this system, if a city wishes to own a given utility or all of its utilities, it may not build anew and disregard the property rights of existing utility companies, but should purchase such properties at fair valuations. Neither should a city grant a franchise to a second company which proposes to compete with the first, even though it were offered a valuable consideration for such franchise. The justification for all this, of course, is that one company with all the business of a given utility can usually render better service than two or more could do with the business divided between them.

To secure good service and good management, competent managers and superintendents and operators must be employed, and the rates paid by the customers of the utilities (whether for gas or electricity or water, or for telephone or street car service) must be high enough to permit good salaries and good wages to be paid. In short, the public pays all the expenses of operating the utilities, including salaries of officers, wages of employes, cost of expert engineers, dividends on capital, taxes, waste due to inefficient management if there be such, graft or commissions on purchases if any, and the expenses of the public service commission which regulates the utilities, and it gets in return such service as the utilities render at rates from which there is no appeal except to a public service commission, where there are such commissions.

It may appear to some that a public service commission is going beyond its proper sphere when it inquires into questions of efficiency of management and honesty of administration. But if it be conceded that the stockholders are to receive a fair return on their investment, and the public is to get no better service than the company can give, consistent with such dividends, it is readily seen that any loss due to inefficiency of process or apparatus, or to incompetent or dishonest management, comes mainly, if not entirely, out of the public rather than from the officers or stockholders.

The fundamental relationship existing between public and its public utilities is that of principal and agent. It is not to be expecter that regulation can be realized everywhere at once. It will require years to develop the new system to a state approximating completeness and perfection. In the meantime all degrees of regulation may be expected, down to the merest beginnings in which rules are adopted and reports received, but inspections are scant and rates are scarcely considered.

QUANTITY AND QUALITY OF SERVICE.

The principal elements which determine the value of service as well as of commodities are quantity and quality; in some cases the time and rate of delivery are also important elements. The quantity may be measured by meters—for example, gas meters, electric meters or water meters—or by count or time, as in telephone service—or by the number of rides or distance traveled, as in street railway service. There is no absolute standard of quality of public utility service. In general, the better the service the more it costs, although the difference in cost between good and indifferent service is not the same under different circumstances.

Thus, in a large city continuity of service and uniformity of voltage in electric lighting may be secured at a smaller relative increase in cost than in a smaller city; and the requirements as to continuity of service and quality of transmission may be higher in an underground telephone system than in an overhead system. Aside, however, from any question of difference in quality of service due to different conditions, it is difficult enough to specify what constitutes safe and adequate service under average conditions, and very few public service commissions and very few utility companies have as yet attempted to do this for the electric utilities. For gas service it has been done more or less successfully for many years, and many cities have ordinances which specify the service required, and in some cases gas inspectors make systematic tests to ascertain whether the service specified is being furnished, and often fines are imposed if it is not. The Bureau of Standards has made an extended study of the subject of specifications for manufactured gas and gas service, and a detailed report on the subject has been published. But no corresponding publication has been issued for electric service.

RELATION OF QUALITY AND COST.

A similar thorough study of the electrical utilities should be carried out, and the requirements of good service under varying conditions formulated, and the relation between improved quality of service and the increase in the cost of the same determined. The life of electric lamps and their candle power vary greatly with change of voltage, and hence good service requires steady voltage. This involves good construction, competent operation, correct instruments, and careful inspection or voltage surveys. Again, rules with regard to frequency of street railway service, per cent of passengers seated in rush hours, character of cars, and quality of the heating, lighting and ventilation of the same, must all be made in view of the expense involved, for the public cannot get any more than it pays for, and under ideal regulation the requirements are so made that the public gets the maximum of service, considering quantity and quality, for every dollar expended.

STANDARDIZATION OF SERVICE.

These considerations lead irresistibly to the conclusion that an important work may be done in standardizing public utility service, not with a view of requiring all companies to conform to one standard, which would be impracticable, but to have standards that can be adapted to different conditions, and that can be used to judge the performance of any given utility.

An important reason for such standardization of service is that managers and directors of utility companies may know more definitely the kind of service they should strive to give the public, and have a definite guide in planning extensions and improvements. Better service will generally involve more expensive equipment and more intelligent and hence more expensive labor. Whether a manager is spending the stockholders' or the public's money, it is very desirable that as definite service specifications as possible be formulated for his guidance, both in the equipment and in the operation of his plant. This does not mean that such rules be carried to unnecessary extremes, but that in a careful and conservative way and with the co-operation of the utility companies, rules be prepared which are both reasonable and progressive. It would thus be possible for utility companies who chose to do so to conform to requirements so fully as to leave little in the way of enforcement for the commissions to do. In other words, they may be largely self-regulating, just as other corporations may obey the law voluntarily if the law is sufficiently clear and explicit so that it can be readily understood. For the information of the public, it is also of importance to have such specifications, that it may be generally known what the companies are expected to do. Managers of utilities can report their performance to the municipalities or public service commissions, and they can receive public credit for good performance as well as criticism for poor performance.

CO-OPERATION NECESSARY.

Obviously, however, no single state commission could undertake to establish such standards of efficiency and performance for all the utilities under all the different conditions found in practice. Neither can it be expected that the utility companies themselves will ever formulate such standards. The only practicable way of accomplishing the desired result is by co-operative effort between the commissions and the utilities of the whole country. And the most practicable way of securing such co-operation appears to be for the federal government to assist in the undertaking. The federal government, through the Agricultural Department, the Geological Survey, the Bureau of Mines, the Public Health Service, the Bureau of Education and other bureaus and departments, is co-operating with the states in many important lines of work, and such work is done by the federal government, not because the states cannot do it, but because the federal government can do a certain part of it much better than the states, and the co-operation and unity of effort thus brought about are of great value to the country as a whole.

WORK OF THE BUREAU OF STANDARDS IN STANDARDIZATION OF SERVICE.

In the same way the federal government has been co-operating to some extent, through the Bureau of Standards, with the state commissions and the utility companies in the standardization of practice and of service, but the limited resources of the bureau have permitted only a very limited activity thus far. The need of more extended work of this kind has been so generally felt that the Secretary of Commerce has asked Congress for a larger appropriation for this work, and the National Association of State Commissioners, and individual commissions as well, have expressed the hope that the appropriation would be granted. The Bureau of Standards would in that case be able to maintain an able staff of engineers and experts who could carry on investigations that would be of value in the work of regulating intelligently and justly the various utilities. It could serve as technical adviser to the state commissions in so far as they chose to avail themselves of its services, and it would act also as a court of appeals for the utility companies on technical questions. It would, of course, have no legal jurisdiction over any utility, and so would not infringe upon the prerogatives of the state commissions. But the moral influence of its opinion might be of some value to a commission when the public was expecting the impossible or a utility was demanding too much, or to a utility that was required by order or ordinance to do what was unreasonable.

It would be unsafe to predict exactly what could or could not be done by the Bureau of Standards along the lines indicated, but it seems safe to believe that its work would be as well done and prove as valuable and as satisfactory as the work of this kind that it has done during the past three years. This work has been carried on in a scientific spirit, with no bias for or against the utility companies, with the closest co-operation of engineers and operators of long experience, and with no ambition save to do work that would be of value and that would merit the commendation of unbiased judges. It appears certain that a larger activity of the bureau in the field of public utility regulation, studying the problems coming before state commissions and municipal regulating bodies open-mindedly, and yet conservatively, serving as a clearing house of information as well as an agency for investigation and the formulation of results for general use, would be productive of valuable results which would more than justify the cost.

Many of the state commissions recently established have abundant authority, but very limited funds to provide an engineering staff. The work of appraisal and inspection is expensive, and the states will have to grant considerable sums for this work, even if the federal government cooperates with and assists the state commissions in the way and to the extent proposed.

INVESTIGATIONS NOW IN PROGRESS.

The bureau is investigating and testing measuring instruments used by utility companies, such as gas and electric meters, and electrical testing instruments, calorimeters, photometers, and the methods of measurement and testing employed, as well as investigating the manufacture and distribution of illuminating gas. One phase of the latter subject that has received considerable attention is the most economical heating values for different kinds of gas. At the present time the bureau is making a study of this question with reference to gas made from crude petroleum as it is done on the Pacific coast, this study being undertaken at the joint request of the public service commissions of Oregon and California and a committee of the gas companies of the coast. The results of this study will be utilized by the state commissions in fixing the requirements of their respective states as to the heating value of the gas.

An extended study has been made of the damage caused to gas and water pipes, lead cable sheaths and reinforced concrete by the electric currents of street railways as they flow through the ground on their way back from the cars to the power houses, and of methods of preventing such damage, and very valuable results have been obtained. The handling of this subject by public service commissions is perhaps not expressly authorized by law, but as it is a case of the electric current used by one utility destroying the property of others, it is of concern to these commissions, and the methods employed by the bureau are applicable generally.

An extensive study of the life hazard in electrical practice is now being made by the bureau (acting in co-operation with certain engineering societies), with a view of formulating rules of construction and practice to reduce the danger to employes and the public arising from electric light and power circuits.

RATES AND APPRAISALS.

The consideration of rates charged for public utility service may be divided into two parts: First, what average rates must be charged in order that the company may have sufficient revenue to pay expenses, provide for repairs and depreciation, set aside something for surplus or sinking fund, and pay the necessary dividends; second, how shall these charges be distributed among the different classes of customers for the different grades of service? In other words, what scale of charges is equitable, supposing the total necessary income or average charge for service has already been fixed?

To illustrate, in some places where the charge for electric current is 10 cents per kilowatt hour for the ordinary small user of current for light and power, the prices are scaled down as the quantity and load factor are increased (and according to the effect of the load on the station's diversity factor) until for the very largest users it is sometimes as low as 2 cents, and even in some cases 1 cent per kilowatt hour. On the other hand, the price of gas to different customers seldom varies by so great a ratio as two to one, and often the rate is the same to all customers, regardless of quantity or cost of delivery. There are good reasons why the difference should be less for gas than for electricity, but there appears no sufficient reason why practice should vary as much as it does in different places, either in gas or electric rates. Much intelligent study has been given to the subject of rates, especially by the utilities and a few state commissions, but there is still much difference of opinion concerning both the theory and the practice. Rates are fixed with regard to other considerations besides the cost of the service, and the valuation of such considerations as well as of the cost is difficult indeed. Improper discrimination in electric rates should not be allowed, but a proper discrimination or differentiation is necessary. How to distinguish between what is proper and improper is the main question. It is of great importance that the state commissions co-operate in their study of the problem, and, as far as possible, adopt uniform methods of determining rates, and the utility companies should welcome such study.

Appraisals are often necessary in connection with the fixing of rates. Generally appraisal engineers are employed by state and city commissions to do this work. As the company whose property is being appraised is necessarily represented in the work, it is desirable that the commission be represented also. The appraisal engineers aim to be just and unprejudiced. To secure the best results it would appear that the commission should be represented by one or more experienced engineers not connected with the appraisal firm. These may be engineers belonging to th commission's permanent staff, or they may be engaged for the occasion. Methods and unit values employed by different appraisal engineers should be compared and studied and, as far as possible, uniform methods formulated.

RELATION OF STATE COMMISSIONS TO CITIES.

In most states that have general public service commissions their authority extends over the public utilities of all the cities of the state. In some cases the cities would have preferred to retain this control, but it is usually thought better to have a single commission for all the utilities of a state. However, that does not relieve a city of all responsibility concerning its utilities. On the contrary, a city may, if it chooses, keep very close account of the operation of its utilities, and if service or rates are not satisfactory it can take its complaint to the state commission. The latter will be able to hear a well-prepared case in far less time than it could investigate and act upon the complaints of individual customers. Hence, if a city provides for competent inspection under the service rules adopted by the state commissions, it will be in a position to know the character of service its utilities are furnishing, and to secure prompt redress if complaint, sent first to the utility companies, are not satisfactorily adjusted. It seems probable that this course will be adopted by many cities, as few if any state commissions will have a large enough force to do all the required inspection and investigation to secure adequate regulation for all the utilities of a state. It appears likely that the Bureau of Standards, with an enlarged staff, will be able to assist many cities in establishing the technical work of such inspections, both in states where there are and where there are not state commissions. Such local inspection work ought to be standardized in the interest of both the public and of the utility companies.

With the utilities taken out of politics, with rates and service determined by permanent commissions acting intelligently and judicially, and the financial conduct of public utility corporations controlled so as to protect both the stockholders and the general public, but without restricting unfairly the development of the business, public utility securities will be safe and popular investments, needed capital should be secured more readily than ever, and the utility companies and their stockholders should gain as much from commission regulation as does the general public.

A Convenient Voltage Drop Diagram for Transmission Line Calculations

(*Contributed Exclusively to* ELECTRICAL ENGINEERING.)

BY MERWYN C. RODIE.

THE writer has devised a simple form of voltage drop diagram which he believes will be found very serviceable in cases where a considerable amount of line drop computation is done for a few standard forms of transmission line. The diagram is easily constructed, and while it applies only to the particular form of transmission line for which it is made up, results are obtained from it much more readily than it would be possible from a diagram which is general in its application. The line drop per thousand feet is read directly from the diagram for the given value of current and power factor. Thus all computation is eliminated except the multiplying of the drop per thousand feet by the number of thousand feet in the length of the line.

By line drop is meant the arithmetical difference between the voltages at the sending and the receiving ends of the line. This, of course, is not the same as the voltage consumed by the impedance of the line which must be subtracted vectorially from the sending voltage to give the receiving end voltage. The line drop then will vary with the power factor of the receiving circuit. Where the voltage consumed in the line is not unusually large, the voltage

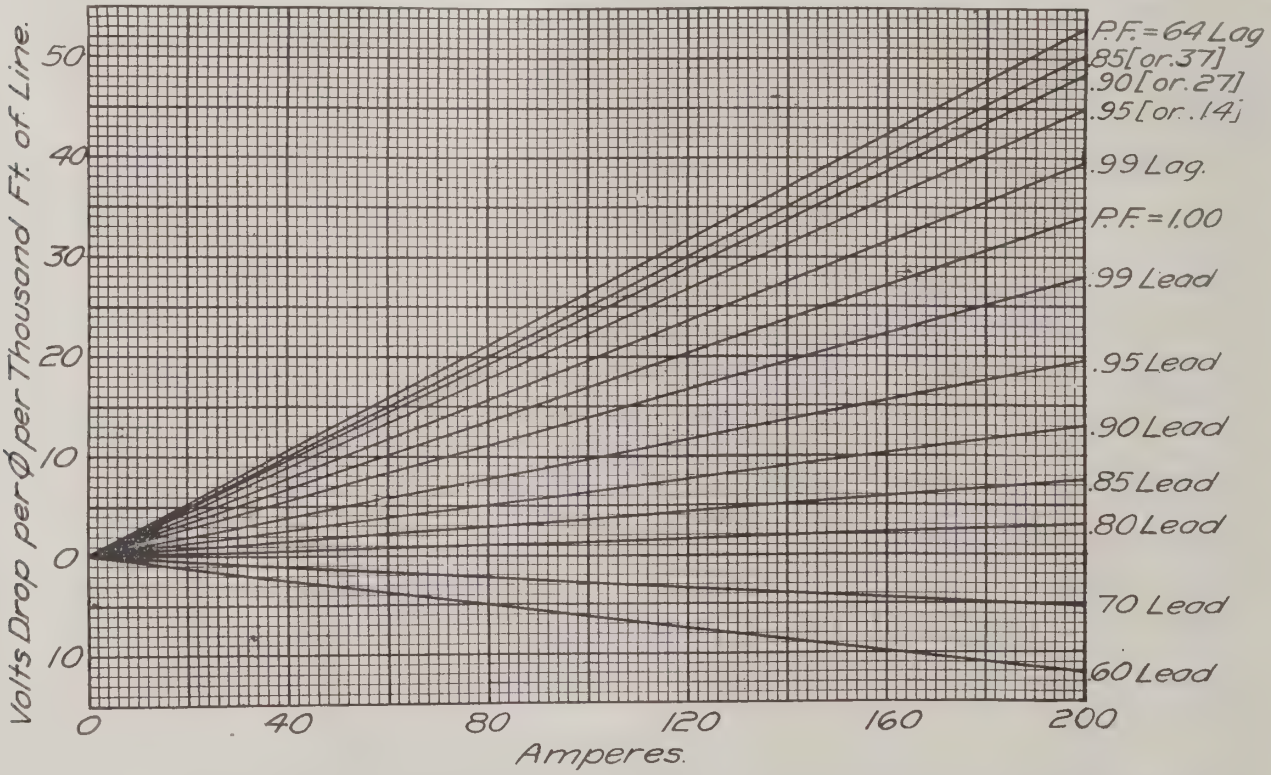


FIG. 1. VOLTAGE DROP DIAGRAM FOR 3-PHASE LINE OF NO. 0 COPPER CONDUCTORS SPACED 21 INCHES AND FREQUENCY OF 60 CYCLES.

drop at a given value of power factor is almost exactly in direct proportion to the line current. Hence a straight line will show the relation between the line current and the voltage drop for a given value of power factor, and by plotting a number of these lines we obtain a diagram, as shown in Fig. 1, which shows this relation for any value of power factor. Since all of these lines pass through the origin, it is only necessary to compute one point for each line.

To show the method of constructing the diagram, let us assume a No. 0, 3-phase transmission line with the wires spaced on 21 inch centers in equilateral triangular position. The resistance of No. 0 copper wire at 20 degrees C. is .0981 ohms per thousand feet, and the reactance at 21-inch spacing and 60 cycles is .1175 ohms per wire per thousand feet. The impedance is $\sqrt{(R^2+X^2)}$ or .1531 ohms. Let us assume an arbitrary value of current as 200 amperes. Then multiplying the impedance by 200 and by $\sqrt{3}$ we get 53.03 volts consumed by the impedance per phase per 1,000 feet of line at 200 amperes. The voltages consumed in the line by R (resistance), X (reactance), and Z (impedance), are represented in Fig. 2 as AB, BC, and AC, respectively. OC represents the sending voltage and OA the receiving voltage. Angle OCD is the angle whose sine is the power factor (measured at the sending end). Subtracting from this angle the angle ACB, whose tangent is R/X, we get angle GCA. Multiplying AC by the cosine of angle GCA, we get the value of GC. This value, plotted on the diagram as the voltage drop per thousand feet at 200 amperes and at the power factor for which the computation was made, determines one of the lines of the diagram. In mathematical language, $D = V \cos. [\arcsin\ (P.\ F.) - \arctan.\ R/\omega L]$ where D is the voltage drop and V is the voltage consumed by the impedance of the line. For some values of power factor $[\arctan.\ R/\omega\ L]$ will be greater than $[\arcsin.\ (P.\ F.)]$ so that the subtraction will be reversed. Where the power factor is leading, the formula will become $D = V \cos. [\arcsin. (P. F.)] + \arctan. R/\omega L$.

The points on the diagram may also be obtained by a very simple graphical construction. The voltage triangle ABC (Fig. 2) is thus constructed. Then for any given value of power factor the line representing sending voltage is drawn, making the proper angle with AB extended and AC is projected graphically upon this line.

Where the voltage consumed by the impedance of the line is very large, the drop as obtained by the use of the diagram is not accurate at all values of power factors. The true voltage drop in Fig. 2 is the difference between the lengths of OC and OA. This is not exactly equal to GC. The true voltage drop is not exactly in direct proportion to the length of the transmission line, while the voltage represented by the projection GC is in direct proportion to the length of line. The diagram always gives for the drop that quantity which would be obtained by projecting the impedance volts AC upon the sending voltage OC, and the error is in any case the difference between the lengths of the lines OA and OG. It is zero at that value of power factor which makes AC coincide with OC and is a maximum at approximately that value of leading power factor which makes AC perpendicular to OC. The maximum error in these diagrams is approximately 1¼, 2½, 5 and 7.5 per cent of the impedance volts where the impedance volts are 2.5, 5, 10 and 15 per cent, respectively, of the line voltage. However, the error is much smaller at the more usual values of power factor. In the No. 0 3-phase line assumed above, the error in the diagram is 0.93 per cent of the impedance voltage when the power factor is 0.90 lag and where the impedance volts are 10 per cent of the line voltage. At the same power factor, when the impedance volts are 5 per cent, the error is 0.45 per cent of the impedance volts or about .023 per cent of the line voltage. In this diagram the error is zero at P. F. = .64 lag and a maximum at approximately P. F. = .77 lead.

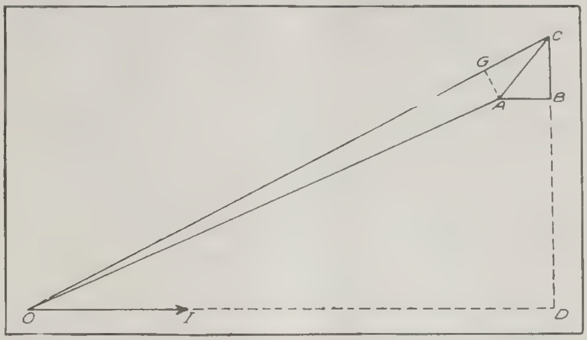


FIG. 2. GRAPHICAL CONSTRUCTION OF VOLTAGE DROP DIAGRAM.

Electrical Features of the Panama-Pacific International Exposition.

(Contributed Exclusively to Electrical Engineering).

BY ARTHUR H. DUTTON.

IN addition to being up-to-date in every particular, the electrical lighting and power systems of the Panama-Pacific International Exposition at San Francisco in 1915 will include some conspicuous features so novel as to deserve the designation of steps into the future of electrical engineering. Chief among these will be the system of illumination, which will be almost revolutionary in its character, containing at least eighteen details that will be adopted at this exposition for the first time in the history of decorative electrical illumination. Instead of following the old custom of outlining the various palaces and other architectural structures by means of incandescent lamps, the entire facade of each building and tower will be flooded by means of screened luminous arcs and hidden batteries of searchlights; instead of presenting an array of white lights, the system will present a brilliant, but not dazzling illumination, in all colors of the solar spectrum, the light emanating not from within, but from without.

With the exception of the small amounts of power generated by electrical exhibits in operation, the entire electrical current for the exposition, for both power and lighting, will be obtained from the Pacific Gas & Electric Company, of California, which supplies service to the city of San Francisco and many other California cities and towns.

The work of installation of underground conduits for the distribution of electrical power and light has progressed rapidly, and all buildings and structures throughout the grounds will be amply provided in this respect. In the exhibit palaces the light will be furnished from 60-cycle, 3-phase, 4-wire mains, having a voltage of approximately 115 between conductors and neutral. The lighting elsewhere will be served from 60-cycle, single-phase, 3-wire mains, having a voltage of approximately 115 to neutral and 230 between outside conductors. Throughout the grounds, power will be served from 60-cycle, 3-phase and single-phase service, at 230 volts. In addition to alternating current service, mains for the distribution of direct current at 125 and 250 volts will be installed in the Palaces of Machinery, of Mines and Metallurgy, of Transportation, and of Manufactures.

In the matter of load requirements, the assumption was made that the only buildings that will be open at night will be the Festival Hall, the Ferry building and the Palaces of Transportation and Fine Arts, the Service building and the various administration buildings. All the other exposition buildings were assumed to be closed at night, although account was taken of the short days when the lighting load will overlap the day motor load. The average requirements for patrol and janitor service and lighting of main exhibit palaces was based upon 1-10 watt per square foot of building area. Additions to this were made to cover requirements for motors, booth lighting and lighting of detached buildings and incandescent decorative lighting.

In the states and foreign and federal government districts, the load was based on one watt per square foot of building area. The average peak load demanded in this section was taken at 2,000 kilowatts. In the concessions district the demand was assumed as 2,500 kilowatts, this estimate being based upon lighting loads equal to 40 per cent of the capacity of the installed transformers, plus the motor loads in the corresponding district in the St. Louis Exposition. The total average night peak has been taken as 8,500 kilowatts. The capacity of the conductors is such as to provide for dark days, when exposition grounds lighting would begin before closing down of the motor load, which makes the exposition peak 11,500 kilowatts.

All electrical energy will be distributed throughout the grounds at a primary voltage of 4,000 A.C., with secondary voltages as before noted. Present indications are that while the exposition voltage is 4,000, the generating voltage will be about 11,000, and be stepped down to the exposition primary voltage. In the event of the central station of the Pacific Gas & Electric Company being temporarily disabled, power will be obtained from other sources possessed by the company.

As stated before, the electrical conduits throughout the main exhibit, the concessions and the states and foreign districts, will be underground, but an overhead system will be carried around the rear of the concessions district and at the extreme western part of the grounds, about the race track and aviation field. The overhead system is to be of the standard pole line construction. The underground system is based upon the use of wood fiber duct and manholes of wooden construction.

A box or trough construction will extend between manholes and will vary in size to suit the number of ducts to be provided. The space between the duct and the wood trough is to be filled with sand, except at the entrance of the manholes, where four lineal feet of concrete will be used. This particular type of underground conduit was adopted because of its mechanical strength and economy. The short life of the exposition required an economical design throughout, and attention is called to the fact that the average cost of installation is, in round numbers, 10 cents per duct foot with the wood manholes of the shallow type averaging $25 apiece, the deep section type averaging $50 each. No subway type transformers will be used, as all transformers will be placed in the main exhibit palaces. Vaults for the transformers will be required in a number of the states' and foreign nations' buildings, and this will be provided for by special arrangements with the designers.

The luminous arcs which were considered in the foregoing estimates of average peak and peak load, are part of the electrical layout for decorative purposes. These arcs will have special diffusing globes to keep the intrinsic brilliancy low. These will be used in the streets and courts of the exhibit section, to illuminate the facades of buildings and courts. Some special features not yet fully determined upon, in the way of water and light effects, will occur in some of the courts. From the lamp standards which are used for facade lighting, there will be hung banners which act as screens. These banners will be ornamental and of appropriate design, and will form a component part of the scheme. Unique window lighting effects will result, as all exterior windows are to be glazed with a translucent glass, which will diffuse the light from the lamps that are to be suspended between the openings.

To produce the illumination effects mentioned at the first of this article, the various parts of the towers and colonades will be picked out by means of imitation "jewels," as they are called, which are cut-glass gems of highest grade, the facets being all tin-polished, and the "jewels" being of various colors. They will be placed in such manner as to move easily under the influence of the breezes, which will cause them to scintillate in the sun's rays by day, and in artificial beams by night. By means of electric searchlights projected upon them, they will exhibit all the primary colors at night, ever scintillating. From the experiments already made with small specimens of the means of general illumination, it is promised that the effect of the whole will be that of a veritable fairyland of many colored twinkling lights, indescribable in either words or picture.

Another feature of the night illumination will be what may be called an electric pyrotechnic display. This will be produced by a battery of electric searchlights placed upon an imitation fortress at the entrance to the yacht harbor on the north side of the exposition grounds. These searchlights will play various colors into the sky, the frequent fogs that enter San Francisco Bay in the evenings making an admirable background for them. When there is no natural fog, an artificial fog will be produced in the vicinity by large volumes of steam that will be thrown into the air for the lights to play upon, with their many-colored beams.

The Bureau of Illumination is under the Department of Electrical and Mechanical Engineering. The chief of the bureau is Mr. W. D'A. Ryan, of the General Electric Company. The chief of the department is Mr. G. L. Bayley, member of the American Institute of Electrical Engineers and of the American Society of Mechanical Engineers.

Exhibition Sales Conference Held by Western Electric Company at Atlanta, Ga., Possessed Interesting Features.

At Atlanta, Ga., on January 26 to 30, the Western Electric Company held an exhibition sales conference for its southern district. This type of conference is now a new and established part of the work of the sales organization and possesses new and commendable features. The conference derives its name from its very nature, the exhibit feature and inspection of apparatus being the special purpose of the meeting as a part of a campaign to familiarize salesmen with all the essential details of every line of apparatus the company handles. To provide the proper display of such apparatus, a large hall was arranged with booths and the equipment displayed after the manner of exhibits at important conventions. The first conference of this kind to be conducted by the Western Electric Company was held at New York in January of last year, and the second in February at Chicago, Atlanta being selected for the third. All the meetings have shown such results that it is planned to hold them as often as the development of new apparatus and the employment of new salesmen demand.

In an interview with Mr. M. A. Oberlander, chairman of the committee having the conference in charge, the following explanation of the work and aim of the conference was given:

"The business of every meeting is conducted according to a prearranged program which divides up the time of the salesmen in attendance so as to enable each one to make a study of all the different types of apparatus on display and discuss any new features as well as those on which he may not be thoroughly informed. In order to secure a record of the proficiency of each salesman in his work and to secure an index of his knowledge of the details of the apparatus on display, a report card is arranged covering each piece or group of apparatus inspected, which report card is held by the party in charge of these groups. After a salesman has visited and examined the apparatus, the one in charge enters on the card a rating of the salesman's knowledge of the apparatus as can best be obtained. This record thus indicates to every salesman and to the sales organization alike the nature of the apparatus not thoroughly understood by salesmen, and on which more detailed and definite information should be secured. The conference, therefore, has a tendency toward increasing the efficiency of the sales organization."

The Western Electric Company, aside from being the largest manufacturer of telephone equipment, acts as a distributer of electrical merchandise on a large scale, and the exhibits at a conference of this nature include apparatus of many manufacturers. These displays are presided over by specialists, which feature supplements in an admirable and practical way the aim of the meeting as already explained, and unables salesmen to secure first-hand information on all equipment and clear up points not well understood by discussing same with these specialists in both design and sales features.

The following is a partial list of the suppliers having apparatus on display at the Atlanta conference: American Ever Ready Company, American Cross Arm Company, American Electric Heater Company, Benjamin Electric Manufacturing Company, Bryant Electric Company, Crouse-Hinds Company, George Cutter Company, D & W Fuse Company, Duncan Electric & Manufacturing Company, Duplex Metals ompany, Edwards & Co., Electric Storage Battery Company, Holophane Works, Hughes Electric Heating Company, Harvey Hubbel, Inc., Hubbard & Co., W. N. Mathews & Brother, Phillips Insulated Wire Company, Stanley & Patterson, Weston Electrical Instru-

View of Exhibit Hall at Western Electric Sales Conference, Hotel Ansley, Atlanta, Ga.

ment Company, Walpole Tire & Rubber Company, Pyrene Manufacturing Company.

The following representatives of the above companies were in attendance: W. G. Mills, H. Ball, A. F. Crosby, B. H. Scranton, Robert Kuhns, E. Doherty, C. D. Wayre, F. V. Burton, W. A. Stacey, A. F. Hills, C. M. Crofoot, H. H. Park, F. X. Cleary, W. S. Sisson, Fred Doublebower, T. K. Stevenson, T. H. Bibber, A. N. Bentley, A. I. Sundheimer H. B. Lane, J. M. Smith, W. E. Trittipo, J. R. Field, H. W. Bliven, J. W. Morey, C. L. Pierce, Jr., C. L. Matthews, H. C. Adams, Jr., F. H. Eastman, W. V. Dolan, A. J. Hitzker, F. J. H. Price, S. A. Chase, T. J. McGill, L. O. Duclos, H. C. Futch.

The southern representatives of the Western Electric Company attending the conference were as follows: From Atlanta; Mr. E. J. Wallis, district manager; Mr. T. A. Burke, sales manager, and seventeen salesmen. From Richmond, Va.: H. W. Hall, manager, and ten salesmen. From New Orleans, La.: E. H. McFall and P. E. Davidson. From Dallas, Texas: R. W. Van Valkenburgh, manager; W. J. Drury, sales manager, and ten salesmen. From the main office of the company at New York the following were in attendance: P. L. Thomson, advertising manager; A. G. Kingman, advertising department; G. K. Heyer, railway telephone sales engineer; M. A. Oberlander, assistant supply sales manager; F. D. Killion, H. P. Marshall, H. H. Montague and H. P. Howard.

The details of the conference were in charge of the following committee: M. A. Oberlander, chairman, and E. J. Wallis, T. A. Burke, H. W. Hall, W. J. Drury and A. G. Kingman.

Engineering Department of Harvard University Combined With Massachusetts Institute of Technology.

The board of overseers of Harvard University and the corporation of the Massachusetts Institute of Technology have effected an important forward movement in the conservation of educational forces by entering into a co-operation in technical educational work. The co-operation is definitely limited to the fields of engineering—mechanical, electrical, civil and sanitary and mining—all of which involve great expense in the maintenance of extensive and costly laboratories. It is agreed that all the work of education and research in these important branches of applied science shall be carried on within the buildings of the institute to be erected on its new site in Cambridge, bordering on Massachusetts avenue and the Charles River embankment. These buildings are being erected, arranged and equipped with a full knowledge of the best already existing in the world and with means and intention to surpass all others in fitness for their purpose. For the maintenance and equipment of these laboratories and the payment of salaries, the university agrees to set aside practically all the money that it would otherwise be free to devote to education of this type. Technology, on its part, agrees to devote to the same general purpose all the funds or the income of funds that it now holds for carrying on work in the departments of engineering that have been named, and both institutions agree that their respective measures of support may be increased from time to time if disposable funds are available.

The faculty of Technology shall be enlarged by the addition to it of the professors, assistant professors and associate professors of the four departments in the Harvard Schools of Applied Science, who, retaining their titles and privileges in Harvard University, will acquire the corresponding titles and privileges in the institute. Similarly, the officers of corresponding rank in the four departments in the institute will acquire the same titles and privileges in the university. The work of instruction and the laying down of courses leading to degrees is entrusted to the enlarged faculty of the institute. The enlarged faculty will have a double duty to perform: Under regulations from the institute's corporation it will lay down engineering courses that lead to the degrees of the institute, and under regulations from the university it will lay down comparable courses that lead to the degrees of the university; unless the regulations of the two corporations are different, the courses leading to both degrees will almost certainly be identical.

Membership of Society for Electrical Development Passes 1200 Mark.

At the time this issue of *Electrical Engineering* goes to press, the membership of the Society for Electrical Development is 1,211. The plans of the organization are rapidly taking definite form, and actual campaign work is to start with determination at an early date. In regard to recent developments and progress, Mr. J. M. Wakeman, general manager of the society, writes as follows:

"Our new membership list came off the press today (January 19), and I am sending herewith one of the first finished copies of it. You will note that it contains 1,195 names, of which 520 are contractors, 252 central stations, 248 jobbers and dealers, 159 manufacturers and 16 miscellaneous. Our membership today is 1,211, sixteen applications having been received since our membership list went to press—that is to say, on Saturday—so that we are progressing very satisfactorily.

"It is also interesting to note that we are receiving daily inquiries in the shape of letters, telephone calls and personal calls at the office, such inquiries ranging from the cost of a flatiron and its maintenance to the cost of completely wiring a house for full electric service. The wide range and number of these inquiries clearly indicate the necessity for an organization such as the Society for Electrical Development, from which the public can feel that they can obtain information without having to go to a company having something to sell. It also indicates that as soon as the society is in a position to make itself widely known, there will be plenty of work for it to do, and great opportunities for educating the public and developing the electrical industry. We hope to be in a position to begin active work by the first of March."

1915 International Electrical Congress at San Francisco.

During the Panama-Pacific International Exposition in 1915 the International Electrical Congress is to be held at San Francisco, September 13 to 18, under the auspices of the American Institute of Electrical Engineers by authority of the International Electrotechnical Commission. Dr. C. P. Steinmetz has accepted the honorary presidency of the congress. The deliberations of the congress will be divided among twelve sections which will deal exclusively with electricity and electrical practice, and about 250 papers will be presented.

It is important to note the distinction between this Electrical Congress and the International Engineering Congress, which will be held at San Francisco during the week immediately following the Electrical Congress. The Engineering Congress is supported by the Societies of Civil, Mechanical and Marine Engineers and by the Institutes of Mining and Electrical Engineers, as well as by prominent Pacific coast engineers who are actively engaged in organizing it. The Engineering Congress will deal with engineering in a general sense, electrical engineering subjects being limited to one of the eleven sections, which will include about twelve papers, treating more particularly applications of electricity in engineering work.

Plans are already well under way for one or more special trains from the east to San Francisco in connection with the International Electrical Congress. The tentative program, which at a later date will be submitted in detail to the engineers of the United States and other countries for an expression of their individual preferences, includes a round trip of about thirty days' duration, with stops in Chicago, Colorado Springs, Salt Lake City, San Francisco, Santa Barbara and Los Angeles. At each one of these places special arrangements will be made by local committees for the comfort and entertainment of the members of the party. The transportation committee of the congress is further considering the possibilities of marine transportation by way of the Panama Canal. There appears to be a considerable demand for this, especially if satisfactory arrangements can be made for combining the land and water features.

Correction of an Error in January Issue.

In the January issue of *Electrical Engineering,* on account of a press room accident, the illustrations on pages 24 and 36 were interchanged and a part of the issue printed and mailed before the error was noticed. Those readers who have read the interesting article by Mr. Barrett on the Panama Canal as a factor in American commerce, and the one by Mr. Baldwin on Latin American trade, will please note that the photograph illustration of Mr. Barrett should appear on page 24 and that of Mr. Baldwin on page 36. In some of the copies, the illustrations appear correct and to make sure that this explanation shall be correctly understood, the illustrations are presented herewith.

Hon. John Barrett, Director General, Pan American Union.

Hon. A. H. Baldwin, Chief of Bureau of Foreign and Domestic Commerce.

Electrical Steel Furnaces in England.

According to a statement in a recent issue of the *Consular and Trade Reports,* the first English plant devoted exclusively to making steel by the electrical process is being erected by the Stobie Steel Company, of Sheffield, on the banks of the River Tyne at Dunston, near Newcastle. The furnace room is a steel structure 250 feet long, 60 feet wide and 50 feet high, with a bay 26 feet wide running the whole length. A testing laboratory for determining the thermal behavior of the steels, and still another for the micrographic research so necessary to the steel industry, will occupy a portion of the same building. The furnace installation consists of one 15-ton electric furnace, operating on three-phase current, which will be used for melting; one 5-ton furnace, which will be operated on two-phase current and be used for refining; and one 300-pound furnace for ferroalloys, to be operated on single phase. The furnaces are to be operated from a steel platform.

The current will be three-phase, 40-cycle and 6,000 volts, and the transmission line will be in duplicate from the supply station. The furnace switch house is of ferroconcrete, 25 by 25 feet, located adjacent to the furnace room, and contains 11 panels of high tension feed and switch gear. Access to this building is direct from the furnace platform as well as from the floor level. The transformers serving the cranes, auxiliary motors and the lighting service are also located in this building. The current supply to the furnace is regulated automatically, which prevents the heavy fluctuations that would otherwise take place. The tilting is done by electric power. A track runs down the center of the shop, and pig iron, scrap and other heavy raw materials are unloaded from the cars by crane service and an electromagnet. Other such materials as lime, sand, dolomite and magnesite will be delivered into the bay that parallels the furnace platform.

New Business Methods and Results

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

The Public Service Company and Employee—Welfare Work—Benevolent Association.

With the rapid expansion of many modern industries, the individual, as an employer of labor, has almost if not entirely been superseded by the corporation, and conditions between employer and employe have radically changed. With greatly increased transportation facilities, rendering possible the mobilization of thousands of workmen on short notice, a labor market has been created in which a certain degree of knowledge or skill possesses a certain definite and recognized value. Bonds of affection, friendship or acquaintance no longer figure to any great degree in the employment of labor, and this, combined with the fact that labor, skilled and unskilled, can be procured at any time in almost any quantity, renders the modern system of employment, as practiced by corporations in general, a strictly business proposition. Systems of scientific management, when first introduced, although possessing many excellent features, contributed not a little to the lack of personal interest in the employe as a man. In the systom there is a tendency to consider him a cog in a machine, costing a certain wage, based upon the production of a specified amount of a given product. His comfort, personal habits or good will were not always properly considered, and such indifference to anything but the economic value of the laborer has gone far toward creating the not altogether undeserved phrase, "the soulless corporation."

This attitude toward labor, when carried to its extreme limits, has naturally opened the way to various abuses, not at all willful, but the result of lack of consideration of the ultimate results. These conditions have attracted the attention of reformers; agitation has followed and led to legislation against such matters as child labor, excessive hours of railroad and other employes, providing for sanitary inspection, compulsory adoption of safety devices, and other needed reforms.

At the present time a reaction is taking place, and labor conditions and relations between employer and employe are being given a consideration and study as never before. Many companies, either from humanitarian motives or from a realization of the fact that it is good business policy, are making provision for the physical, intellectual and social needs of employes. Among those classes of employers giving this matter its due consideration, the public service companies appear in the front rank. In considering the reasons why public service organizations should be interested in the welfare of their workers, we find, first, that employes whose physical and mental development is good, who work in comfort and amid agreeable surroundings, under reasonable regulations, do more work, do better work, and more willingly than those where such conditions are neglected.

To properly carry out these ideas, in the power house and on the line work, every practical safety device should be provided and its use insisted upon. Such things pay big dividends. It is not merely the loss in damages that measures the cost of an accident, for of greater importance is the loss of confidence on the part of workmen, the creation of an impression of carelessness, indifference, and a feeling of distrust in the company, its employes, and electrical apparatus in general, vague in some cases, perhaps, but real in its ability to create public opinion of the least deserved nature in the majority of cases.

The second reason why the public service corporation is especially interested in the welfare of its employes is that from their very nature such corporations are dependent for their prosperity, and even their very existence, upon public favor. Next to good service as an asset comes courteous dealings with customers and prompt attention to complaints by loyal employes. There is no one thing that will make or mar the reputation of a public service company as surely as the kind of treatment it accords to those who work for it, so that the very best advertisement a company can have is an evident indication that all of its employes are proud of their connection with it. The good will of the employes is no small factor in securing the good will of the public of which they are a part.

As regards welfare work, now an important part of public service companies' activities in improving the conditions of employes, the most common features are the maintaining of libraries and reading rooms, recreation and rest rooms, gymnasiums and athletic grounds, emergency hospitals, etc. Which of these are practicable largely depends upon the size of the company and the facilities which the town affords for these things. For instance, in some cases a restaurant would be a superfluity, in other cases almost an absolute necessity. Some sort of a general assembly room, with magazines, comfortable chairs and writing tables, with a lecture room near by which can be used for meetings, lectures or social events, could probably be provided in every case, and in many cases meet many needs. These attentions make the employe feel that the company has an interest in him beyond simply his labor, if they are established without a patronizing spirit and every employe made to feel that these things are his by right and in appreciation of faithful and loyal service, the use of which incurs no obligation whatever, beyond that his interest in the company and his work would naturally suggest.

The idea of club rooms naturally suggests that of organization. The tendency toward organization among workmen is strong, as shown by the advance in organized labor. While not opposing labor unions as such, it is our opinion that for the purpose of developing co-operation and sympathy between the public service company and its employes that a benevolent or mutual aid society, with every employe a member, is much preferable. In the first place, there is no exclusion, no dividing lines as to occupation; the control is local; there are no outside disturbing factors to create unwarranted discontent. In the case of a grievance, a good local organization, by proper methods, can do as much or more to secure adjustment as an outside organization, and in every case leaves the management in a better frame of mind.

The benevolent society does not in any way relieve the company from the responsibility arising from accident in the performance of duty, but adds its help in such a case, besides taking care of sickness, distress and natural death arising from causes over which the company has no direct control. Such a society is naturally an organization controlled entirely by the men themselves. The company may, however, suggest a form of organization, and should in all cases provide a meeting place and allow the officers of the society a reasonable amount of time and liberty to care for the duties of their office, and in general stand back of the scheme. The company should handle the association's surplus funds if desirable, subject to immediate order, paying interest therefor, and in other minor ways help the work along. Such an association, if properly conducted, is of great value in holding the men together and securing their loyalty.

As examples of what some concerns have done outside the central station industry, we first pay respect to one of the very first concerns to take up the matter of welfare work—the National Cash Register Company. Without describing its work in detail, it is to be noted that this company carries on all the forms of work mentioned above, with several others, all well developed and greatly appreciated. Heinz & Co., of Pittsburg, makers of the famous "57 varieties," are also leaders in this work, as well as the Curtis Publishing Company, the home of the *Ladies' Home Journal* and the *Saturday Evening Post.* We mention these concerns to show that "big business" is awakening to the fact that there are some things that cannot be expressed in dollars and cents.

In the central station field we can mention the Denver Tramways Company, whose Mutual Aid Association is now in its fifth year. In its magazine, published for the educational and social benefit of its members, we find "Safety Tips;" also such articles as "Preventing Step Accidents" and "Handling School Children." The motto of the company in this respect is "Never Take a Chance."

The *Union Electric Bulletin,* of St. Louis, calls particular attention to safety, and gives notes on first-aid methods, showing the operation of the lung motor, etc. Another conspicuous example is to be found at Rochester, N. Y. The motto of the Rochester company is "Help Us Prevent Accidents." The company provides every device known to lessen the risks of its workmen and requires their use. Regular instruction is given the men on such subjects as the handling of high tension, etc. At a recent meeting a lecture was given by one of the officers at which 100 lantern slides were shown illustrating safety devices and their use, as well as wrong and right ways of doing things, and other suggestions for the avoidance of danger. This company has a flourishing benevolent association, which is a strong feature in promoting interest and loyalty.

The National Electric Light Association has appointed a new safety committee, which is now conducting a campaign of investigation having as its aim the prevention of accidents. A report of the campaign plans appears elsewhere in this issue. Other central station organizations are also taking up the work on a large scale, and the movement promises to be national in scope.

A. G. Rakestraw.

COMMENTS FROM READERS.

A. E. Holman, Manager Meter and Contract Department, Anderson Branch of Southern Public Utilities Company, Anderson, S. C., Describes Methods for Securing Electric Sign Business.

Of the central stations in our small cities throughout the south, too few realize the possibilities of new business. Usually the duties of commercial agent, superintendent and general manager all rest upon one man, and sales work is secondary to his other duties. The securing of new business is, therefore, given very little thought, and he falls in the rut of letting his customers take the initiative. To illustrate, the writer has in mind a remark made a few days ago by a superintendent of a plant in a town of 5,000 inhabitants. Referring to the chairman of the board, he said: "The old man will buy anything that comes along. He bought a dozen electric irons the other day and told me to get out and sell them." This, of course, is an extreme case, and this superintendent was unfitted for the job.

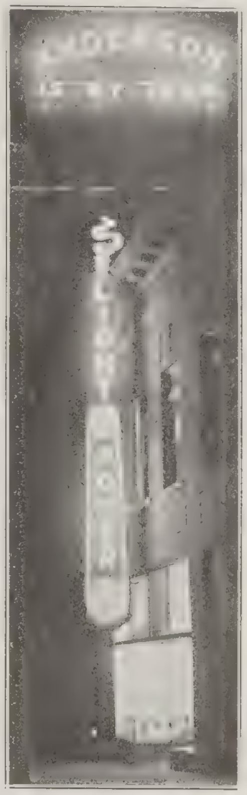
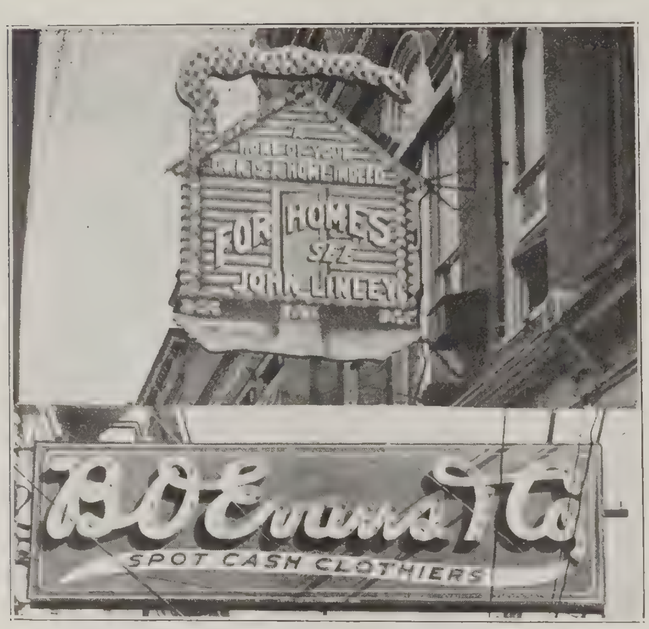


Fig. 1. Anderson, S. C., Town Slogan Sign at Top With Central Station Sign Below.

The development of things electrical has been so rapid and startling since its beginning in the industrial field that the public in general accepts each new device as a matter of course. With the introduction of the new metal filament incandescent sign lamp, with its high efficiency and long life, a new field in sign lighting has been opened from which a rich harvest can be gathered, as the writer will attempt to show in what follows:

Before electric signs can be properly promoted an ordinance must be passed favoring their erection. Usually by co-operating with a city council, the very argument against promiscuous use of all kinds of signs can be used to advantage by specifying that only electric signs shall be used. In the writer's town this has been done, and an ordi-



FIGS. 3 AND 4. REPRESENTATIVE ELECTRIC SIGNS AT ANDERSON, S. C.

nance stipulates that only electric signs shall be erected over sidewalks, and goes on to specify three candle power per square foot of sign surface, with the construction entirely of metal, thus eliminating the merchant who would erect a canvas sign with a lamp or two in the corner and call it an electric sign.

For the central station man who is about to start out to sell signs, a few points might be mentioned for his consideration. He should first encourage customers to invest in a sign that will be artistic and raise the standard of such effects in the community. This need not be any more expensive than one designed in violation of good taste. The up-to-date merchant values any investment in advertising by the increase of business, and should be approached from this most valuable standpoint. He already advertises in the newspapers—here is a sign location for which he is paying high rent—a valuable advertising space to be filled.

As to the rate, it is the writer's opinion that a special flat rate for burning a certain number of hours, based on the wattage of the sign, has many advantages over the meter rate, as a guaranteed cost of power for operating can be made and useless hours of burning eliminated. Too much stress cannot be laid on erecting. The factor of safety should be 100 per cent. This, together with construction details, should be stipulated by the city council.

The illustrations shown here are representative of electric signs erected at Anderson within the past year. Fig. 1 is our town slogan, erected by the Chamber of Commerce, and contains 220 10-watt, 11-volt lamps. This slogan is used quite extensively by our people in advertising the town. Often one runs across a man registered at a hotel from "My Town." Fig. 2 is a well-balanced central station sign with the torch effect and pulleys and belt. Fig. 3 is one representing the trademark of one of our most progressive real estate men. "The Log Cabin, a Home of Your Own." This sign is lighted by 350 5-volt tungsten lamps, with the smoke coming from the chimney. Fig. 4 is the autograph of one of our leading clothiers. This sign is lighted by 225 5-watt lamps, using the grooved letter, which enables one to read this sign for several blocks at night. The sign transformer is usually erected as near as possible to the sign to reduce wiring expense and drop in line.

Eugene Creed Opens Electric Shop of Kentucky Traction & Terminal Company, Lexington, Ky.

One entire building, located in the traffic center of Lexington, Ky., has been arranged and fitted up as a combined interurban and city car station and office building for the Kentucky Traction & Terminal Company. The top floor is devoted to executive offices, the second is laid out as a clubroom for employes, with billiard and pool tables and other accommodations for the pleasure of employes.

The "electric shop" is located on the first floor, and arranged and equipped in the most modern fashion, with displays of all kinds of electric appliances and devices. Another part of this floor is used for the station, with both white and colored waiting rooms and all accommodations, and a method of announcing time of departing trains by means of a system of clocks.

Considerable activity in new business matters has been shown in Lexington since Mr. Creed organized a new business department something over a year ago. An electric sign campaign has recently been conducted, during which twenty signs have been sold and seventeen rented, ranging in price from $150 to $465. Since the opening of the "electric shop" early in December an average of six pieces of heating and cooking appliances have been sold daily for operation at the lighting rate. This activity is now at its height, and some interesting information will undoubtedly be available at an early date.

New Business Results of W. C. Duncan, the Youngest Manager of a Public Utility We Know of, Warrant Doubling of Plant Capacity.

Since the purchase of the central station property at Bay City, Texas, by the Texas Public Service Company, new business has been secured to such an extent that the station capacity must soon be doubled. The plant now contains 125 Hp. of boiler capacity, 150 Kw. in generator capacity, and a two-panel switchboard. The added equipment will give 250 Hp. in boilers, 300 Kw. generator capacity, and increase the switchboard by two panels. In addition, a complete new fireproof boiler room is to be erected, two concrete ice vaults installed, and pumps and accessories to serve the needs.

The following items show the new business secured and connected to existing lines:

Cotton Gin	150	H. P.
Waterworks Pumping	20	H. P.
Steam Laundry	10	H. P.
Planing Mill	15	H. P.
Wood Yard	7½	H. P.
Blacksmith Shop	5	H. P.
Two Ice Cream Factories	7	H. P.
Garage	3	H. P.
Printing Office	2½	H. P.
Three Coffee Mills in Stores	1½	H. P.
	221	H. P.

Lighting Customers, Jan. 1, 1914	440
Lighting Consumers, Oct. 1, 1912	305
GAIN	135
City Street Lighting, Jan., 1914, Monthly	$103.50
City Street Lighting, Oct. 1912, Monthly	78.00
GAIN	$ 25.50
White Way since July 1, 1913, Monthly	$55.00
Railroad Lighting, Jan. 1, 1914, Monthly	$72.00
Railroad Lighting, Oct. 1, 1912, Monthly	50.00
	22.00

In connection with these results in a town of 3,100 inhabitants, it is interesting to know that they have been secured by a manager of the new school just twenty-five years old, one of the youngest managers we know of, and one to whom many with more years of experience must give due recognition for an increased load in a town of 3,000 possessing no important industries, during sixteen months, of 221 Hp. in motors, 135 lighting customers, with a monthly lighting increase in revenue of $102, is no small record. We have learned that the secret of this work rests in the ability to secure "team work" from employes and establish and maintain a progressive public policy. When a profitable business was solicited and secured, the service was made satisfactory. The new business work has been done so well and on such a co-operative basis that the power customers, in recognition of the money they are saving over steam and gasoline power costs, are "boosters" for electrical power. Conditions are not so different in other small towns—but how many, we ask, can beat this record?

Chart Showing Use of Electric Light Longer in Winter Than Summer.

The accompanying chart is being used by the Union Electric Light & Power Company of St. Louis to show customers that electric light is used more during winter than during summer, and thus the reason for bills being higher during winter.

The chart reads from left to right for the twenty-four hours of the day, and from top to bottom for the months of the year. The shaded portions represent hours of darkness; vertical lines marked 7 a. m. and 10 p. m. represent hours of rising and retiring; double cross hatched portions represent hours when light is not used; small figures indicate the hours of the day when artificial lighting is first or last needed, and large figures indicate the total number of hours of artificial illumination per month from dusk to 10 p. m. and from dawn to 7 a. m. This chart is an ideal means for comparing summer and winter use of illumination, and satisfying those customers who do not understand the considerable increase of winter bills.

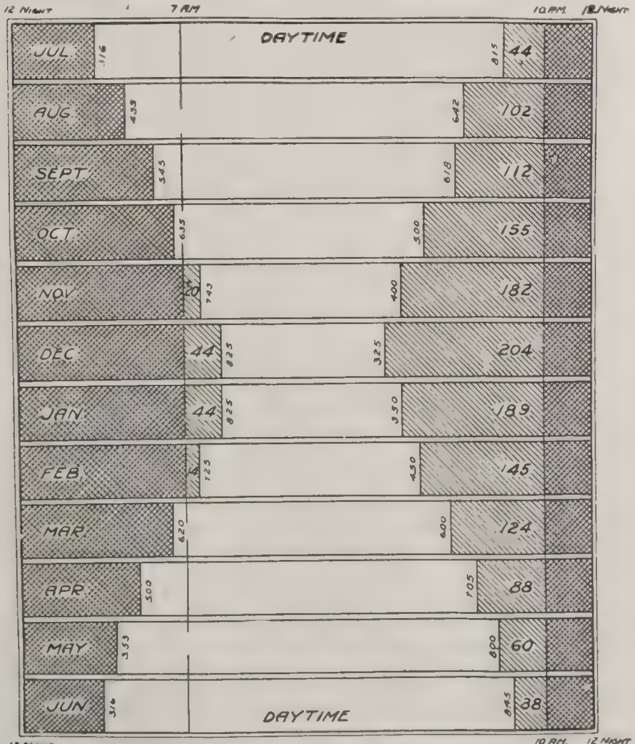


Chart Showing Comparison of Light Used During Seasons of Year.

Christmas Appliance Campaigns of Byllesby Properties.

Reports received from twenty Byllesby electric properties concerning the holiday electric appliance sales indicate that the total number sold last year at all properties will be exceeded. The figures, which include all appliances sold by companies, dealers, contractors and others handling electrical goods, show that a total of 5,080 appliances were sold during 1913 as compared with 4,587 for the same properties in 1912. The total number of appliances sold at all properties last year was 5,825. There are twelve properties from whom reports have not been received this year, and it is believed the total number of appliances sold at all properties for 1913 will be approximately 700 greater than this figure.

Economic Operation of Battery Driven Fire Truck.

The cost of operating New York's only battery-driven fire engine, according to data recently compiled, has more than justified the substitution of this truck for the horse-drawn apparatus. Not only has a big saving been effected in cost, but the added advantage of much greater speed has been a source of great satisfaction.

The total cost of operating the truck, which is of the couple-gear type, over a period of one year, is estimated at $388.74. The following items are included:

Depreciation	$200.00
Current at 6c per kilowatt-hour	117.90
Distilled water, sulphuric acid, brushes for the motor, and other minor repairs	70.84
Total	$388.74

A comparison of this with the cost of operating a horse-driven engine shows a saving of $266.52 in favor of the battery-driven truck.

Horse-drawn truck	$655.26
Battery-driven truck	387.74
Saving	$266.52

During the year covered by the above costs the battery-driven truck responded to 319 alarms. One run of six miles was made through the crowded city streets in 23 minutes, with the truck exceeding at times a speed of 20 miles an hour. The storage battery equipment used consists of 80 cells known as the U. S. L. thin plate type, as manufactured by the United States Light & Heating Company, of Niagara Falls, N. Y.

A good general light is desirable in the public portions of public, semi-public, and semi-private buildings where reading and writing do not take place; where this does occur a reading light should be attainable.

A strong reading light is requisite in theaters for the reading of programs, in the centers of living rooms, and of libraries in private houses, in the service portions of public buildings, in court houses, and at times in the auditoriums of churches.

Questions and Answers from Readers

Readers are invited to make liberal use of this department for discussing questions, obtaining information, opinions or experiences from other readers. Discussions and criticisms on answers to questions are solicited. However, editors are not responsible for correctness of statements of opinion or fact in discussions. All published answers and discussions are paid for.

SPECIFICATIONS FOR GENERATING EQUIPMENT FOR SMALL CENTRAL STATIONS.

Editor Electrical Engineering:

(432) The writer is figuring on installing generating equipment to light a town of 3,000 inhabitants. The estimater lighting load that can be secured at once consists of 70 100-watt series street lights, and 300 house lights of about 25 watts each. On account of the fact that there is little possible motor load at present, the writer believes that a generator of 20 Kw. is sufficient for the initial installation. We are at present figuring on a gasoline engine belted to a generator of this capacity. Information on size of equipment to check the size mentioned as well as any other suggestions regarding the installation of apparatus based on requirements of similar towns will be appreciated. Should A. C. or D. C. equipment be installed? If D. C. 110-volt apparatus is installed, can the same distribution lines be later used for single-phase operation at a higher voltage, that is, will the wire size be satisfactory? Or can a third wire be added to the pole line with any economy for 3-phase operation if later the load should reach say 30 or 40 Kw. and demand an increased generator capacity? The two wire distribution will of course be planned and installed on the basis of 20 Kw. load. Name apparatus and sizes for station equipment, including generator, (if 20 Kw. size is not enough or too much), switchboard instruments, and provisions for series street lighting. What should approximate cost of the plant be ready to run? Itemize equipment if possible. B. J. K.

REDUCING SUPPLY VOLTAGE FOR A PARTICULAR LOAD.

Editor Electrical Engineering:

(433.) The writer has an electric sign operated from D. C. 114-volt supply, made up of 190 6-watt, 6-volt lamps connected in 10 series groups of 19 lamps, each group across 114 volts. As operated at present the lamps burn out continuously and the writer thinks it advisable to reduce the voltage to say 105 volts. Please advise the best possible way to do this and if by use of a resistance state the amount and give a method of calculating same. It may be of interest to say that other sign circuits operated at the same voltage but using 5-watt, 13-volt lamps 10 in series burn all right. This is our first experience with the 6-watt, 6-volt lamps and hope to find some arrangement so that they can be used satisfactorily. We are using 40 of these lamps wired in 8 sets of five, in series multiple without any loss of lamps, but this arrangement is not exactly satisfactory. It seems best to insert a resistance between the sign and the fuse and locate it at the fuse block. Any suggestions will be most welcome. K. W. Hill.

COST OF SWITCHING APPARATUS FOR 11,000 VOLT LINE.

Editor Electrical Engineering:

(434) Supplementing the writer's question, No. 429, in the January issue, I would like to get an estimate of the cost of switching apparatus necessary on a 11,000-volt line such as mentioned. At the plant would a plain exposed single pole disconnecting switch in each line be sufficient with an oil switch at the substation? In general what protective apparatus is necessary for the 11,000-volt line. F. S. F.

NATURE OF FIELD OF SINGLE-PHASE MOTOR.

Editor Electrical Engineering:

(435) Does a single-phase motor have a revolving field after the starting arrangement has been cut out? If a field or stator were made of a design similar to the Edison two-pole D. C. type motor and wound for 110 volts, single-phase alternating current, would a squirrel cage rotor revolve in the field set up? If the stator frame were square as in the Lincoln two pole generator, would the effect be any different? If so, why? O. P. S.

CROSS CURRENTS BETWEEN Y WOUND ALTERNATORS RUNNING IN PARALLEL.

Editor Electrical Engineering:

(436) The question of cross currents between Y wound alternators running in parallel with grounded neutral has come up. Please explain through your columns the following points: (1) Why should cross currents exist between 6,600-volt, Y wound alternators with the neutral point of each of the paralleled machines grounded through a resistance? (2) What is the reason for the switching arrangement shown in Fig. 1, making it impossible to ground two of the machines at the same time? (3) Is there a possibility of cross currents existing in the windings of two or more banks of transformers, Y connected, with neutrals grounded through a resistance and operating in parallel. F. B. D.

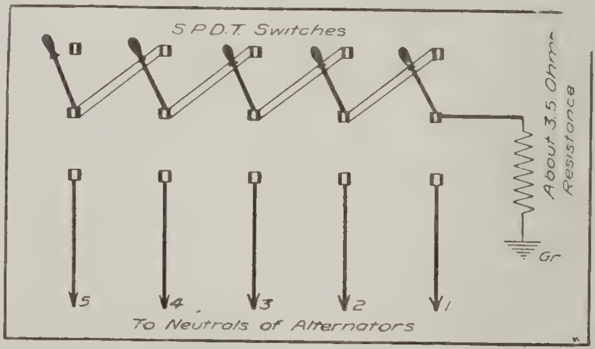


DIAGRAM OF SWITCHING ARRANGEMENT.

220-VOLT INSTRUMENTS ON 110-VOLT CIRCUITS.

Editor Electrical Engineering:

(437) What indication will a 220-volt D. C. ammeter show if used on a 110-volt circuit? Also, what indication will a 220-volt D. C. voltmeter show on a 110-volt circuit? Explain the principle of switchboard instrument operation of Weston design. V. K. S.

Questions Unanswered in 1913 Issues.

SINGLE VS. THREE-PHASE DISTRIBUTION.

Editor Electrical Engineering:

(380) The writer would like to have some reader submit information comparing the cost of single-phase distribution, taking into account cost of wire, transformers, pole material and labor. Also compare effect on regulation and power factor. H. E. R.

USE OF GROUND CONES.

Editor Electrical Engineering:

(407) The writer would like to know if any reader has used the Paragon ground cone for making grounds and with what success. Please outline also proper protection, showing diagrams, for station equipment, arc lighting circuits, high tension lines and low tension a. c. distribution. W. A. R.

ELECTRIC RAILWAY BLOCK SIGNAL SYSTEM.

Editor Electrical Engineering:

(410) Please supply a diagram showing the nature and connections of a manually operated block signal system for a single track suburban electric line. J. H. Bingham.

TRANSFORMER DESIGN TO SUPPRESS WAVE DISTORTIONS.

Editor Electrical Engineering:

(411) The writer has seen the statement that a transformer designed to operate at low densities and low magnetizing current has a tendency to suppress harmonics and wave distortions. Is this the only advantage of such design and the determining factor on size of core, etc? Will some reader explain how wave distortions are suppressed by such design? W. E. F.

COSTS FOR A. C. AND D. C. SYSTEMS.

Editor Electrical Engineering:

(416) Please furnish information or data comparing the cost of installation, losses in transmission and operation of alternating current and direct current systems for general power and traction purposes. S. M. J.

LIGHT ABSORPTION OF GLASSWARE.

Editor Electrical Engineering:

(421) What per centage of the total light of an incandescent unit is absorbed by enclosing glass globes such as used in ornamental street lighting. State for density of glassware that is such that the filament of a 100-watt lamp cannot be seen 14 feet from level of street. H. E. R.

Spacing and Arrangement of Conductors for a Transmission Line. Ans. Ques. No. 412.

Editor Electrical Engineering:

In order to have the inductance of each conductor of a 3-phase system exactly equal to the inductance of each of the other conductors of the system throughout their entire length, the necessary condition is that the conductors (assuming each conductor to be of the same size), shall be located at the vertices of an equilateral triangle as is apparent from the formula for inductances of transmission lines as follows:

$L = 0.7411 \log_{10} d/r + 0.0805$ henries per conductor mile.

Where L = inductance in henries; d = distance between axes of wires; r = radius of wire.

It will be noted that the inductance of a wire varies directly as the logarithm of the ratio of the distance between wires to the radius of the wire, and with wires arranged otherwise than at the vertices of an equilateral triangle, each wire will have a different inductance or, in other words, the inductance of the three wires of the line will not be balanced.

The computation of inductance in each wire is comparatively simple, when the conductors are at the vertices of the equilateral triangle, by applying the above formula, and for this reason the calculations for this condition will be the first considered. In this problem d in the formula becomes 18 inches, and r is one-half the diameter of the copper or 0.23 inch, and the formula becomes,

$L = 0.7411 \log_{10} 18/.23 + 0.0805$ henries per conductor mile. Solving,

$L = 0.0014833$ henries, or 1.4833 millihenries per conductor mile.

The total inductance per conductor would then be, 1.4833×5 miles $= 7.4165$ millihenries.

If it be desired to obtain the inductance per phase of a 3-phase circuit, it may be obtained by multiplying the conductor inductance as obtained above by $\sqrt{3}$ or 1.7321. The total inductance per phase in the above problem would be, $7.4165 \times 1.7321 = 12.84$ millihenries per phase.

It will be noted that the above figures are based on the assumption that solid wire is used. The inductance of stranded wire is slightly different than that of solid wire, but for all practical purposes may be assumed correct.

If the condition of placing all the leads for the above line in the same plane be considered, the line should be properly transposed, otherwise the condition of unbalanced inductance between the outside wires under heavy currents will cause transformer action between the two outside conductors, resulting in an unbalanced load. With wires properly transposed, little error is introduced by taking the distance d of the formula above as the average distance between wires 1 and 2, 2 and 3 and 1 and 3. Thus, d in the formula becomes the average of 18, 18 and 36 inches, or 20.66-in., and r remains the same as in the former problems.

Substituting proper values, the formula becomes, $L = 0.7411 \log_{10} 20.66/.23 + 0.0805$ henries per conductor mile.

Solving, $L = 0.00152$ henries or 1.52 millihenries per conductor mile. In the same manner as previously pointed out, the total inductance per conductor becomes 7.60 millihenries per phase.

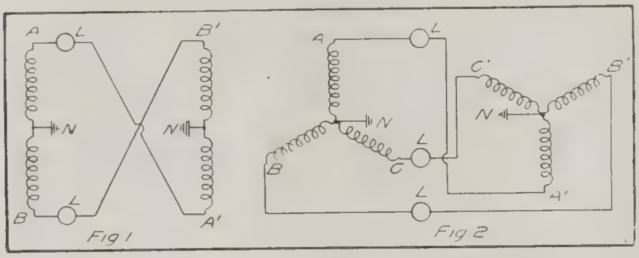
From a comparison of the results of the above solutions, it will be noted that the inductance of the system is greater when the wires are arranged in the same plane than when they form the vertices of an equilateral triangle. Theoretically, the best condition at all voltages from a standpoint of inductances is realized when the conductors are arranged to form an equilateral triangle. There is no defining limit of voltage where the one arrangement should be used in preference to the other. In fact, it is a matter of line construction and the relation of line construction and the electrical properties, rather than voltage, that determines this point. C. L. Searles (Ill.)

Synchronizing With Lamps. Ans. Ques. No. 413.

Editor Electrical Engineering:

Two 220-volt lamps or four 110-volt lamps are required for synchronizing 220-volt, single-phase generators. Three 253-volt lamps or six 127-volt lamps are required for synchronizing two three-phase generators. As a matter of fact, in the latter case 220-volt lamps may be used in place of the 253-volt lamps, though they will have a shorter life.

In explanation, it is thought that less confusion will result if instantaneous values of emf. are used. The effective values, or those indicated on a voltmeter, may be found by multiplying the instantaneous values by 0.707. The instantaneous value of the potential difference between the terminals of a 220-volt alternator passes from a maximum value of 220.x1.414 or 312 volts in one direction, by a harmonic rate of change through zero to a maximum value of 312 volts in the opposite direction. A single-phase, 220-volt alternator may be thought of as having two 110-volt windings connected with an electrical angular displacement of 180 degrees, just as a three-phase alternator may be regarded as having three 127-volt windings placed on the armature at electrical angular distances of 120 degrees. The junction of these separate coils, in either case, may be called a "neutral point," which may be real or imaginary.



CIRCUITS FOR SYNCHRONIZING WITH LAMPS.

In the case of a single-phase, 220-volt alternator with terminals *A* and *B*, the potential of *A* rises to a maximum value of 312/2, or 156 volts above this neutral, and the potential of *B* falls equally to a maximum value of 156 volts below this neutral as the armature or field revolves, and vice versa. A second alternator with terminals A^1 and B^1, revolving at the same speed, might have the potential of A^1 rising at the same time that the potential of A is rising, and the potential of B^1 falling at the same time that the potential of B is falling. Lamps connected, respectively, from A to A^1 and from B to B^1 will not be illuminated, and the two machines are in phase. If the machines are opposite in phase, the potential of A is rising above the potential of the neutral point at the same time that the potential of A^1 is falling below the neutral potential, and vice versa. The terminals A and A^1, then, have a potential difference of 2x156 or 312 volts when A and A^1 are exactly opposite in phase and have reached their respective maximum potential differences of 156 volts from the neutral. See Fig. 1. Each of the synchronizing lamps is then illuminated corresponding to a harmonic or sine wave of emf. with a maximum value of 312 volts or an effective value of 220 volts.

In the case of three-phase generators, a neutral point may also be imagined to exist, and does exist, in fact, if the windings are star or Y connected. With an effective voltage of 220 between terminals, the voltage from any terminal to this neutral is 220/1.732 or 127 volts. The maximum value of this voltage is 127 × 1.414 or 180. As the armature or the field revolves, the potential of the terminals *A*, *B* and *C* passes successively from 180 volts above that of the neutral point through zero to 180 volts below that of the neutral point. When three lamps are connected from terminals *A*, *B* and *C* of the first alternator to terminals A^1, B^1 and C^1 of the second alternator, the lamps are subjected to any voltage from zero, when the potentials of A and A^1, B and B^1, and C and C^1, respectively, are equal and the machines are in phase (if the phase rotation is incorrect, two terminals must be interchanged) to 360 volts when A, for instance, is at its maximum value of 180 volts above the potential of the neutral and A^1 is at its maximum value of 180 volts below the potential of the neutral. In this case the two alternators are exactly out of phase; all three lamps are illuminated and the effective voltage across each is 360 × 0.707 or 253 volts. See Fig. 2.

Prof. H. P. Wood, Georgia School of Technology.

Cost of Operating Steam Plant. Ans. Ques. No. 414.

Editor Electrical Engineering:

Unfortunately Mr. Burch has not given sufficient data to answer his question without certain assumptions. However, I will attempt a general answer, which he can change to satisfy his conditions and show up his operation.

First, he states that he has 1,300 horsepower in boilers, but he does not say whether the total is being used all the time or not, neither does he give the size of the different units. He also says that he has three prime mover units, giving the size of each, but does not say whether or not all are running continuously. Neither does he tell how many hours per day he is operating, all of which must be assumed.

We will assume that his 1,300-horsepower boilers are divided into four units, each 325 horsepower. We will also assume that all prime mover units are operating at the same time. If we assume that he uses an open feed water heater, from which he can secure feed water practically at the temperature of the steam, then we can determine from the temperature of the feed water the back pressure he is running on his prime movers, namely, 224 degrees would indicate 4 pounds gage pressure, or 4 pounds back pressure. If he has a closed heater, this is not true, as he can not heat the water as hot as the steam by several degrees, therefore, his back pressure would be higher than 4 pounds if he uses a closed heater. We will assume that he has the open type. We must further assume that he carries the same back pressure throughout the year, since the back pressure required on his drivers would be as great as required on the heating system.

Bringing the proposition down to this basis, it resolves itself into a very simple question, namely: What amount of steam would the prime movers consume if they had no back pressure on them, which would be the amount chargeable to power (current in Kw.-hrs.) while the remainder would be that chargeable to the heating and drying processes. Since the above is true it makes very little difference whether we know how many machines are running, for we are interested in how much steam the prime movers consume running under atmospheric conditions, and what they use running with back pressure.

A prime mover of the size given above would be expected to produce a Kw-hr. on about 45 pounds steam when the steam pressure was 125 pounds at the throttle and no back pressure. With 4 pounds back pressure this steam consumption would rise to about 75 pounds per Kw.-hr. Therefore from this we should charge to power, 45 pounds per Kw.-hr. and for heating and driving, 75 —

45 = 30 pounds per Kw.-hr. To get this in dollars and cents we should proceed as follows:

Assuming an evaporation of 8 pounds of water per pound of coal and that coal costs $3.00 per ton at the plant,

440 Kw. × 45 = 19,800/8 or 2,475 pounds coal per hour. With the heating system operating, we would have 440 × 75 = 33,000/8 or 4,125 pounds per hour. Then 4,125 minus 2,475 equals 1,650 pounds per hour, chargeable to heating and drying, and 2,475 pounds per hour to power, or 2,475 ÷ 2,000 times $3.00 equals $3.71 per hour for power and 1,650 ÷ 2,000 times $3.00 equals $2.47 per hour for heating.

In order for Mr. Burch to check these results with his actual conditions, he may compare the total coal consumed from this calculation, which would be 4,125 ÷ 2,000 = 2.06 tons per hour. On this basis, he should be running the four or total boiler capacity, which would check as follows: 1,300 × 30 = 39,000 pounds water evaporated per hour and 440 × 75 = 34,000 pounds consumed by three prime movers plus, say, 10 per cent for auxiliaries, which equals 34,000 plus 3,400 or 37,400 pounds, which checks up fairly closely. While the assumption used in this may not be true, it will show how to solve the problem.

The amount of steam required for heating the boiler feed water should be deducted from the charge of heating and drying in order to determine the exact value for those two items, and may be found as follows: We see from above that 1,300 horsepower of boilers will require 39,000 pounds of water per hour. Each pound will absorb 224 minus 65 or 159 B.t.u.'s of heat. Therefore we will require a total of 39,000 times 6,201,000 B.t.u.'s. Each pound of steam at 4 pounds pressure has 965 (latent heat) B.t.u.'s available for heating and 6,201,000 ÷ 965 = 6,426 pounds steam for boiler feed purposes. Then 6,426 ÷ 8 = 803 pounds coal per hour. Also (803 ÷ 2,000) × $3.00 = $1.20 per hour. This amount should be deducted from the amount required for heating and drying in order to determine the exact amount to be charged to these two items. However, the charge of heating boiler feed water is one that should not be made ordinarily on account of the fact that when the exhaust steam at atmospheric pressure has been released, it is useless unless it can be utilized for heating boiler feed water. Just here we might say that if Mr. Burch would install proper apparatus on his dryers and heating system, he can relieve his prime movers of all back pressure and save the difference or amount charged to the heating and drying.

EARL F. SCOTT,
Consulting Engineer, Atlanta, Ga.

Cost of Generating Steam Power. Ans Ques. No. 414.

Editor Electrical Engineering:

It is surprising to note the little information given by G. T. Burch to aid in the solution of a problem of some importance. With the data as given, it becomes difficult to relate the different steam services one to another, and it can only be assumed that the plant in question is used mainly for the electrical demand, which is not an economical proposition, and that the heating and drying are the only requirements for exhaust steam. Also that no other apparatus uses live steam except some of the auxiliaries.

To fulfill this condition, a 400 horsepower boiler installation will be required for three generators of 200 Kw., 165 Kw. and 75 Kw. each, making the estimated cost of the plant about $44,000. The computed values which follow are based on a maximum capacity of 250 Kw., being equal to an average use for the year of about 160 boiler horsepower. In the attached diagram is shown the relative monthly utilization of the steam services, as based on the elemental variations of light, wind and temperature.

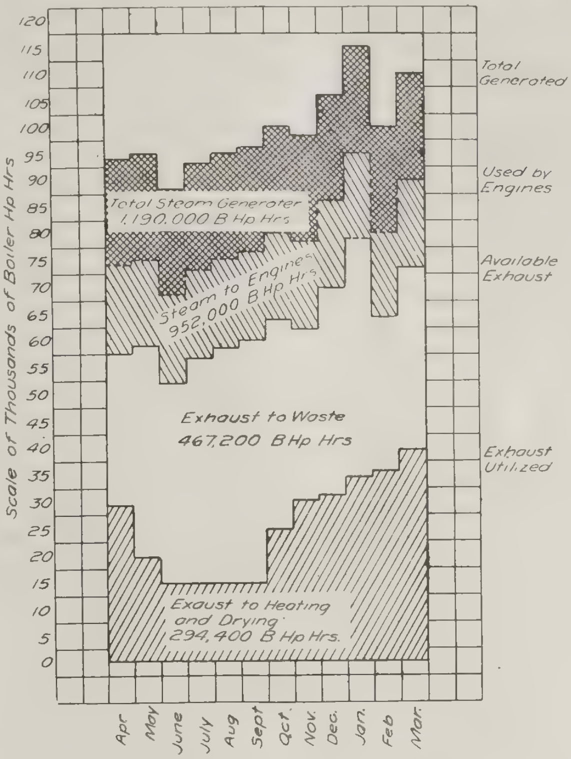


DIAGRAM SHOWING USE OF STEAM.

It is assumed that the amount of steam for driving is the same every month of the year and that the average heating requirements are equal to 40 per cent of zero or the maximum condition. When we get:

ANNUAL DIVISION OF STEAM SERVICES.

Steam generated	1,190,000	B.Hp. Hrs.
Steam to engines	952,000	" "
Steam to Auxiliaries and Transmission losses	238,000	" "
Exhaust Steam Avaliable	761,600	" "
Exhaust Steam Utilized	294,400	" "
Exhaust Steam to Waste	467,200	" "
Total Steam Chargeable to Electricity	896,000	" "
Per Cent of Total Steam Chargeable to Electricity	75.3	per cent.
Equivalent Electrical Energy	595,000	Kw. Hrs.

ANNUAL OPERATING EXPENDITURES.

Fixed Charges	$ 6,600
Labor and Attendance	6,400
Oil, Waste and Repairs	1,400
Coal Used	9,750
Total Cost	$24,150

As the amount chargeable to electricity is 75.3 per cent of the total, the equivalent amount reaches $18,185 and divided by 595,000 kw-hrs. equals 3.06 cents per kw-hr., as against the charge of about two cents by the public service company in Baltimore, the city under consideration.

M. WILLIAM EHRLICH,
Consulting Engineer, New York City.

Cutting Out Coils of a D. C. Generator. Ans. Ques. No. 417.

Editor Electrical Engineering:

When cutting out coils in a 500-volt D.C. generator armature, cut off the coils where they connect to the commutator segments and tape the ends or cut back far enough that the ends can not come out and make contact with other coils, then connect the dead commutator segment to the next live segment. Unless a number of coils are removed in this way, no trouble will be experienced, and then only when they are bunched. When trouble is experienced, it is usually due to an electrically unbalanced armature, which would probably cause considerable sparking at the brushes and a fluctuating voltage. At present the writer is operating a four-pole, 220-volt generator with wave-wound armature, which has four coils cut out and still giving good service. I have operated motors with as many as ten coils cut out, in which case the speed was somewhat increased. I cannot say what the maximum number of coils that could be cut out might be.

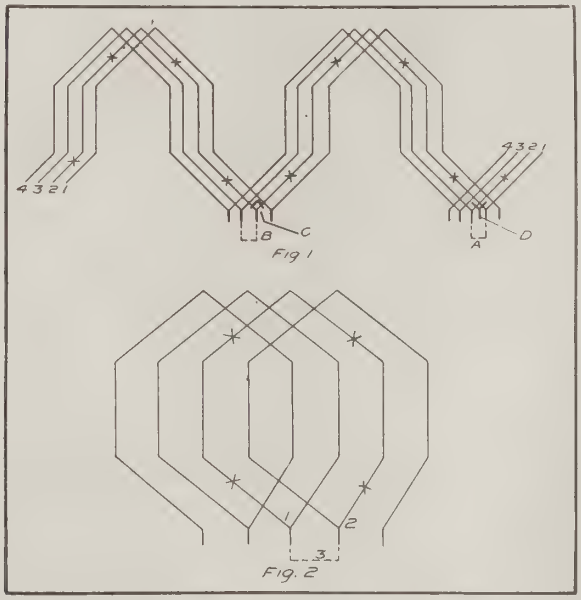


FIG. 1. DIAGRAM OF LAP-WOUND ARMATURE.
FIG. 2. DIAGRAM OF WAVE-WOUND ARMATURE.

In the diagram, Fig. 1, is shown a lap-wound armature. To cut out the marked coils, cut off at segment marked No. 1. If the coil is burned out or grounded on the core, cut off at 1 and 2. Then connect the commutator segments together as at 3. Fig. 2 shows a diagram of a wave-wound armature. To cut out the marked coils, cut off at segments marked *C* and *D* and connect segments as marked at *A* and *B*. H. A. Herstein (Pa.)

Cutting Out Coils of D. C. Generators. Ans. Ques. No. 417.

Editor Electrical Engineering:

The effect of cutting out and bridging one coil, whether in a lap or wave wound armature would be (in a generator) a slight lowering of voltage. In a motor, a slight increase in speed. Also, in an armature whose coils are of comparatively high resistance, the path with the "cutout" coil may heat considerably more than the rest of the winding, especially in a lap wound armature. There is no rule as to the number of coils that can be safely cut out (the less the better). I have run motors of the four pole type with three and four coils cut out. In any case a burned out coil should be replaced as soon as possible. Cutting out and bridging coils is simply a temporary repair in case of emergency.

Changing 220 Volt A. C. Motor to 110 Volt. Ans. Ques. No. 419.

In question 419 W. A. C. does not say whether the motor is of the squirrel cage type or not, but I will assume that it is. To change a 220 volt A. C. motor to a 110 volt take out the rotor and trace out and separate the stator winding into as many groups as there are poles and then divide each group in two and connect the two halves in multiple per pole. Care must be taken that the flow of current will be in the right direction in order to form North and South poles. A. J. Kalinowski (Colo.)

Excluding Dust from Cooling Air for Turbine. Ans. Ques. No. 418.

Editor Electrical Engineering:

In answer to question No. 418, the following device will in the writer's opinion serve the purpose. Make a strong framework completely around the air intake duct. Make frames to fit of some light material say, 2 by one inch, and over these stretch wire screen such as comes off paper machines. This screen is of brass and about 60 mesh and can be easily obtained and will not rust. It will be found best to make two sets so that one set can be cleaned while the other is in use. All that is necessary is to wash these screens with water or blow out with steam. Knobs can be arranged in the stationary frame work for the insertion of these screens. This scheme has been in use on our generators for the past two years and is proving satisfactory.

Harold E. Johnson. (N. Y.)

Changing 220 Volt A. C. Motor to 110 Volt. Ans. Ques. No. 419.

Editor Electrical Engineering:

In order to convert a 220-volt motor into one that will operate efficiently on 110 volts, it is necessary to rewind the motor. When motors are to be rewound, it is advisable to return them to the manufacturer who is familiar with the magnetic and electrical properties and the features of design of the machine. However, if it is not practicable to return the motor to the manufacturer, the following may be of assistance. As no data are given in regard to the design of the motor, the following discussion will be general. The writer assumes that the motor in question is of the induction type, and that the frequency and number of phases of the supply current at 110 volts is the same as the frequency and number of phases for which the motor was originally designed as no mention is made of these features.

The formula for the speed of an induction motor is R. P. M. = 60f/p, where,

R. P. M. = revolutions per minute; f = frequency; p = number of pairs of poles in motor.

From this formula it will be observed that the speed of the motor varies directly with the frequency of the supply current and inversely as the number of pairs of poles for which the motor is wound. Hence if the supply frequency remains the same and it is desirable to rewind the motor for the same speed, it is necessary that it have the same number of poles as the original motor.

From transformer relations, $E = [\sqrt{2} \times \pi \times f \times n \times \phi_m] \div 10^8$, where, E = effective value of primary emf per coil; f = frequency in cycles per second; n = number of turns in series per primary coil; ϕ_m = maximum value of total flux threading through the coil.

Since it is desired to obtain the same power from the motor at the same speed, it is evident that ϕ_m must be the same since in both cases the magnetic circuits are identical, also the frequency f being the same in both cases, the factor $[\sqrt{2}\,\pi\,f\,\phi_m] \div 10^8$ becomes a constant and may be represented by k. Substituting this value (k) in the above formula the latter becomes, $E = k\,n$.

Substituting numerical values for E the equation becomes,

$220 = k\,n$ and $110 = k\,n_1$ or $n_1 = n/2$.

The total power delivered to the motor is $W = E\,I$, where I = primary current. In both cases the power delivered to the motor is approximately the same and $W = 220\,I = 110\,I_1$ or $I_1 = 2\,I$.

From the above deductions, it is evident that the motor should be rewound for the same number of poles as formerly, using the same distribution and connections as at present except that only one half the present number of windings per slot should be used. The wire used should have a carrying capacity double that used in the original winding. With the motor rewound in this manner the speed and horse power of the motor when wound for 110 volts should be the same as previously, when wound for 220 volts.

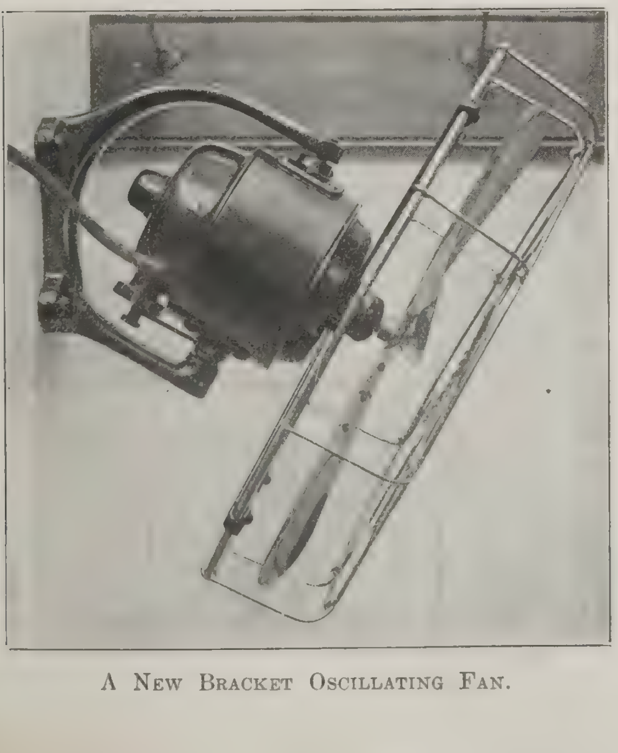
Louis D. Webster, (Ill.)

New Apparatus and Appliances

A New Diehl Bracket Oscillating Fan.

A wall type oscillating fan similar to the one shown in the accompanying illustration was originally designed by the Diehl Mfg. Company, of Elizabeth, N. J., for textile mills manufacturing cotton fabrics to cause an even distribution of moisture laden air to the fabrics. In the design for this purpose the fan body is entirely enclosed and moisture proof. Due to the demand for a fixed wall oscillator for general commercial use, the original design of this fan has been slightly changed and is described as follows:

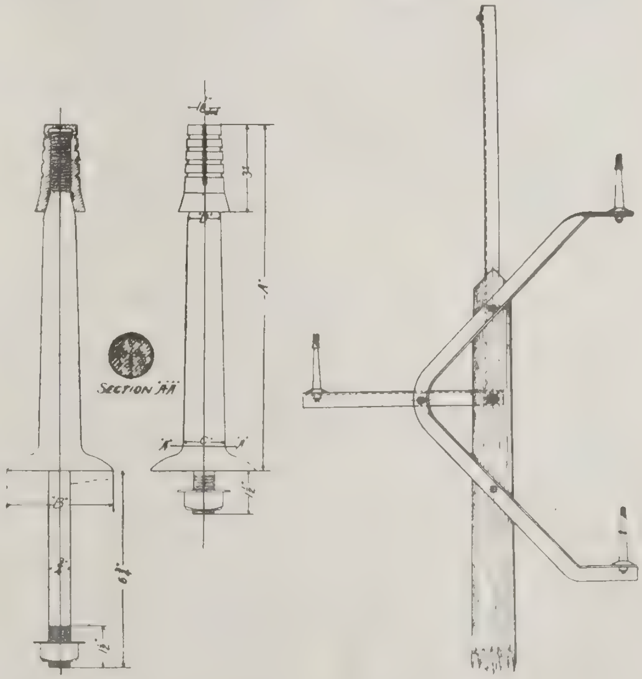
The fan as shown consists of a cast iron bracket inclined at a fixed angle of 25 degrees, equipped with ball bearings allowing the fan body to oscillate with a minimum of friction. The oscillating mechanism is entirely concealed within the rear end cover leaving visible nothing but the revolving disk and lever. By twisting a knurled head in the disk the arc of oscillation may be varied in three steps from 90 degrees to zero, at which point the fan stops oscillating. To take up the forward thrust, the fore part of the shaft is supported by a ball bearing. The body casing and end covers are of pressed metal and the motor frame is composed of laminations, adding materially to the efficiency of the fan. A speed regulator, giving three running speeds, has been designed for use with this fan, but is furnished only on special order and at an additional price.



A NEW BRACKET OSCILLATING FAN.

Forged Steel High Tension Pin.

A new forged steel high tension pin for use on transmission lines has been produced by Hubbard and Company, of Pittsburgh, Pa., which is designed to overcome the inherent defects of malleable and cast iron supports for high tension insulators. In addition, it is claimed that the present design of this pin is lighter, stronger and cheaper than any type of center bolt separable thimble pin. The tapered collar of the thimble of the forged steel pin which is of malleable iron, greatly reinforces the pin at its smallest diameter, thus allowing the use of the standard type of thimble without any reduction in the strength of the pin. When a stress is applied to a pin having a long center bolt, the bolt will stretch considerably, allowing a deflection, which in one case amounted to 5½-in. under a horizontal pull of 1750 lbs., while a forged steel pin subjected to an equal stress deflected only ¼-in. There are no welded joints in this pin, as it is forged from a solid bar of open hearth steel, insuring freedom from flaws. It can be furnished plain or galvanized to meet the N. E. L. A. test in the sizes shown in the accompanying table.



PIERCE NEW FORGED STEEL HIGH TENSION PINS AND BO-ARROW CROSS ARMS.

This pin is made in two styles, shown in Fig. 1, a long shank pin, for use with wood or channel steel arms, and a short shank type for use on arms of angle section, including the "bo-arrow" arm and high tension extension. Fig. 2 shows the type *A* "bo-arrow" arm equipped with the new pins.

The malleable thimble used with the forged steel pin is also used with the high tension channel steel clamp pin for wooden and angle steel arms, and with the various types of pole top pins manufactured by Hubbard and Company. All of these pins, together with the Peirce cone type sheet steel pin, are described in the Hubbard Reference Book of Transmission Line Construction, which is ready for distribution.

TABLE OF DIMENSIONS OF FORGED STEEL PINS.

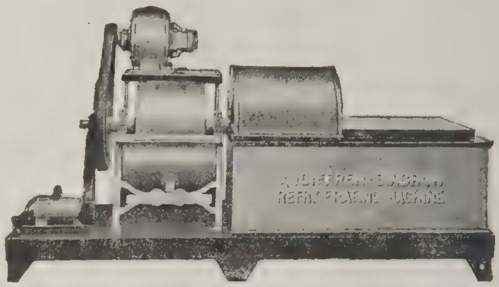
No.	A	B	C	D
2806	6″	2½″	1 ″	1 ″
2807	7″	2½″	1 ″	1 ″
2808	8″	3¼″	1¼″	1⅛″
2809	10″	3¼″	1¼″	
2810	12″	3¾″	1½″	
2811	14″	3¾″	1½″	
2812	16″	3¾″	1½″	
2813	6″	2½″	1 ″	1 ″
2814	7″	2½″	1 ″	1 ″
2815	8″	3¼″	1¼″	1⅛″
2816	10″	3¼″	1¼″	
2817	12″	3¾″	1½″	
2818	14″	3¾″	1½″	
2819	16″	3¾″	1½″	

A French Refrigerating Machine.

This machine has been in operation in France for something like seven years. It is arranged so that it can be applied to any refrigerator (and in the larger sizes to a series of refrigerators), and produces temperatures lower than can be secured with ice, giving a dry cold and the better sanitary conditions that go therewith. At the same time the machine makes such actual ice as is required for table use and for drinks, and holds ready for instant use enough ice to take care of special requirements, such as making ice cream, etc.

The difficulties which have up to the present time stood in the way of sanitary household refrigeration have been the complication involved in all the refrigerating machines available. Most of these machines have used either ammonia or carbonic acid, both of which are subject to considerable danger of explosion from improper handling of the machine. The cost of operation of former machines has also been a serious handicap. The appearance on the American market of the French machine —namely, the Audiffren-Singrun refrigerating machine—marks an advance in the art of refrigeration along original lines. It is the invention of the Abbe Marcel Audiffren, a professor of physics at the former Catholic College at Epinal, France.

In appearance the Audiffren-Singrun refrigerating machine is practically a large dumbbell with a pulley on the end. It consists of a shaft having a hollow drum on one end, another drum at the middle, and a pulley at the other end. The machine operates by causing a liquid to evaporate in the drum at the end of the shaft, drawing the gas resulting from this evaporation in the middle drum through a passage in the shaft. In this middle drum the gas is compressed and returned to the liquid state after giving out its heat, and is then allowed to pass back to the end drum through a second passage in the shaft to be re-evaporated and repeat its cycle of operation. The end drum thus becomes cool and the drum at the middle becomes warm. Water is kept supplied to the middle drum to keep it from becoming too warm, and the cooling effect of the end drum is used to cool brine (common salt and water), which brine is then circulated through cooling coils which may be placed wherever it is convenient.



A French Refrigerating Machine.

Refrigeration secured by these machines is applied to practical service by pumping the brine which has been cooled up to and through the cooling surface which may be placed in the refrigerators to be cooled. Various designs of cooling surface have been developed for use with the machine, a number of which have been developed in this country in adapting the machine to the different conditions existing here. The machine is also arranged so that it starts and stops automatically under the control of the temperatures in the refrigerator being cooled. In this way no power is wasted. When the requirement for refrigeration ceases the consumption of power and water is automatically cut off. The H. W. Johns-Manville Co., New York City, is the American builder of the machine.

Splicing Sleeves for Cable.

A splicing sleeve for use with cables has been devised by Hickey and Schneider, of New York City, made up of annealed seamless copper. It is claimed that these sleeves enable the making of splices in cable quickly and have ample strength and conductivity. In fact, tests recently made on special annealed seamless copper splicing sleeves for a ⅝-inch copper-clad steel cable to be used on the lines of the Utah Power & Light Company proved that a splice made with these sleeves was stronger than the cable, since in all tests made the cable broke without doing any damage to the sleeve. The pull which was put on this cable before it broke was 19,500 pounds, which is within 2½ per cent of the given tensile strength for this size of cable. This form of splice is now in use on copper cables up to 500,000 cm. It is also extensively used for splicing steel grounding lines up to one-half inch diameter, and tests made on high strength steel cable proved that the cable would break without doing any damage whatever to the sleeve.

Tests which have been made on copper cable to determine the conductivity of this form of splice have proved it to have an electrical conductivity of over 238 per cent of a piece of cable of similar length. The success of this form of splice is principally due to the special annealing process which this sleeve is put through and the shape of the cross section. It is made so that when twisted together it forms a homogeneous mass, thereby making a perfect electrical contact, and binding the wires so tightly together that they cannot slip. One of the principal features of this sleeve is that it is not necessary to twist the wire at a sharp angle in order to make an efficient splice. For this reason it is claimed that the conductor will not be weakened by a severe twist or bend at too sharp an angle. These sleeves for all sizes, it is claimed, will make a splice that will not weaken the conductor more than 2½ per cent of its guaranteed tensile strength.

Electrical Construction News

This department is maintained for the contractor, dealer, manufacturer and consulting engineer.

ALABAMA.

BIRMINGHAM. The Birmingham Railway, Light & Power Co., has engaged Ford, Bacon & Davis to do engineering work in connection with extensions and improvements to the electric lighting system.

BIRMINGHAM. The Tide Water Power Co., plans to secure a franchise for the installation of a street railway system making connections with the present main lines and to all the principal suburbs of Birmingham.

OZARK. The city is planning the purchase of three 100-horsepower boilers, a 20-kilowatt generator and switchboard and a 300-horsepower Corliss engine. A. F. Dowling is superintendent.

FLORIDA.

HERNANDO. The Florida Power Co., of Ocala, has closed a contract with Dunnellon Phosphate Co., to furnish six phosphate plants with hydro-electric power. The company will build a substation at Hernando and install three 50 K.v.a. water cooled transformers, stepping down from 60,000 volts to 11,000 volts. The distribution lines will be constructed for 11,000 volts and stepped down at the consumer to 2,200 volts.

MUSCOGEE. J. W. Harzey is promoting the construction of an hydro-electric plant across Perdido River and to construct transmission lines to Pensacola, Fla., Mobile, Ala., and other cities.

CHIPLEY. The Chipley Light & Power Co., in considering the installation of a 10-ton ice plant, to be operating in connection with the central station. The purchase of new equipment is contemplated.

TAMPA. The Tampa Electric Co., is to increase its capital stock in order to finance the construction of improvements.

GEORGIA.

MADISON. The electric light and water works is to rebuild its plant and will desire some new equipment.

VILLA RICA. The Villa Rica Electric Light & Power Co., has under consideration the enlargement of its generating station by the purchase of a 50 K.v.a., 2,300-volt generator and transformers. W. B. Powell is general manager.

VALDOSTA. The construction of a power plant on the Willachoochee River about three miles from Valdosta is under consideration. A. B. Langford, of Valdosta, is civil engineer in charge of surveys.

WAYCROSS. The Hebard Cypress Co., is adding generating equipment to its plant, including a turbo-generator, and will sell electrical energy to the Ware County Light & Power Co., for the operating of its electric railway system.

KENTUCKY.

BARBOURVILLE. The Barbourville Electric Light & Power Co., is planning changes to its electric lighting plant.

DAWSON SPRINGS. The Dawson Light & Power Co., has recently been organized to take over the electric equipment of the Dawson Milling Co., and will operate this plant and local transmission lines. E. A. Stephens is manager.

HARLAN. The Kentucky Utilities Co., of Lexington, Ky., has purchased the electric lighting plant of this place and will operate it until transmission lines to the city can be completed.

HORSE CAVE. It is reported that P. G. Vaughn and J. G. Morton will install a 250 Kw., D.C. generator with switchboards, and a 50-horsepower boiler and 30-horsepower engine. Transmission lines will be constructed and an electric lighting business done.

MURRAY. The city light company is to place its feeder wires underground in the business section and install an ornamental street lighting, carrying four 60-watt tungsten lamps.

LOUISIANA.

DE RIDDER. The De Ridder Light & Power Co., is planning the construction of an electric power plant to cost approximately $30,000.

SINGER. J. W. Brown is planning the construction of an ice and electric light plant.

MISSISSIPPI.

ABERDEEN. The city expects to purchase a 150-horsepower engine in the early future. D. A. Stimson is superintendent.

GREENWOOD. The electric light and water works commission is to purchase a 500 Kw. three phase, 60-cycle, 2,300-volt turbo-generator with auxiliaries and switchboards. R. Stott is manager.

NORTH CAROLINA.

HENDERSONVILLE. The Hendersonville Power & Light Co., plans the construction of a dam across the Big Hungry River.

LONG ISLAND. It is understood that George H. Brown, of Statesville, N. C., is planning the construction of a hydro-electric plant at Buffalo Shoals. The development will consist of a concrete dam and a plant of from 1,500 to 2,000 horsepower.

WILSON. Plans and specifications for improvements to the electric light plant have been completed by B. B. White, an engineer of Charlotte, N. C., and bids will be received after the bonds have been sold. The cost will be approximately $80,000.

LOOKOUT SHOALS. The Southern Power Co., of Charlotte, N. C., has decided to develop a water power at Lookout Shoals. This will be the fifth plant to be constructed by the company.

WILMINGTON. The Tide Water Power Co., is to construct a six mile transmission line and purchase auxiliary equipment. Raymond Hunt is superintendent.

SOUTH CAROLINA.

ALLENDALE. The city has engaged the J. B. McCrary Co., of Atlanta to construct an electric light plant

ANDERSON. The Southern Public Utilities Co., plans certain changes and improvements at Portman Shoals and in the city. It is planned to expend about $75,000 at Portman Shoals for replacing the equipment recently destroyed by fire.

ST. GEORGE. The city has contracted with the Modern Equipment Co., of Savannah, Ga., to install an electric light plant.

WOODRUFF. The street lighting system will be changed from arc lamps to tungsten series. Energy is furnished by the South Carolina Power & Railway Co.

TENNESSEE.

NASHVILLE. The Muscle Shoals Hydro-Electric Power Co., has entered a bid for a 100 year franchise on the water power development at Muscle Shoals, Ala., on the Tennessee River. This bid includes a payment of $3,000,000 in cash on completion of locks and substructures and power houses and yearly payments of $75,000 at the end of the first year, $125,000 at end of second year, $150,000 at end of third year, $175,000 at the end of the fourth year, $200,000 at the end of the fifth year, and $240,000 each year thereafter, together with a payment on installation of 30 cents per horsepower per year for each horsepower of installed capacity shown at the switchboard. Another bid was received on June 24th of 1913, from C. E. Jones, of Chattanooga, being a cash bid of $6,250,000 upon completion of locks, dams and substructures of power house.

NASHVILLE. The Nashville Railway & Light Co., plans to reconstruct approximately 30 miles of street railway line in the early future. The Detroit and Nashville Construction Co., has been employed to do the work.

PITTSBURG. The Pittsburg Power Co., is planning to improve its electric light plant by an expenditure of $15,000.

THE ELECTRO DEVELOPMENT COMPANY, 416 Broadway, New York City, has produced a new long life flaming arc lamp. This lamp is described as a short flame, long life lamp of low current consumption designed for alternating current circuits of all frequencies in multiple and series types and also in direct current multiple and series types.

PERSONALS.

MR. S. WOLFF, formerly manager of the Cleveland office of the Allis-Chambers Mfg. Co., has been appointed Chicago manager for the DeLaval Steam Turbine Co., manufacturers of steam turbines, centrifugal pumps, centrifugal air compressors, speed reducing gears, etc., with offices in the Peoples Gas building.

CHARLES H. EGLEE, for nine years general manager of the Ambursen Hydraulic Construction Company, Boston, Mass., in charge of construction work, has become connected with the Aberthaw Construction Company, of Boston, and will have charge of all dam and reservoir work for this company. Mr. Eglee has had unusual experience in the building of all types of dams. In his new connection he will have opportunity to carry on the same sort of work, as well as sea walls and other structures of similar character. While the Aberthaw Company has not previously been active in the building of dams, it has successfully completed thirteen of these structures, five being of considerable importance in size and cost; also a number of tide walls, concrete bridges, etc., all of which call for the same general sort of experience.

MR. F. S. MONTGOMERY, Southern sales manager of the National Metal Molding Company, at Atlanta, Ga., announces that the company's southern office will be moved on February 1st to larger quarters in the Healy building, a new Atlanta skyscraper. The present location is in the Fourth National Bank building, Atlanta.

L. M. ROBERTSON, of Birmingham, Ala., who for some time has carried on an electrical jobbing business in the South, announces that on January 1st his business was taken over by the Robertson Sales Company, Inc., 1905 American Trust building, Birmingham, Ala., with L. M. Robertson, president and treasurer and F. A. Robertson, vice-president

LINN O. MORROW has been appointed manager of a new branch office of the Cutter Electrical Mfg. Company, at Indianapolis, Ind. Mr. Morrow has been connected with the Cutter Company for over six years, having spent some four years in the engineering department. The Indianapolis office will be under the supervision of H. F. Darby, Jr., district manager of Chicago.

MR. E. J. PIETZCKER, formerly southwestern sales manager, has been made western and southwestern sales manager of Standardard Underground Cable Company in charge of the Chicago and St. Louis offices, the combined territory of which embraces the Mississippi River Basin. He will divide his time between these two offices. Mr. Pietzcker has been connected with various branches of the wire and cable industry substantially throughout his entire business experience and is especially qualified to serve the customers of a company which devotes its entire energies to the field of electrical wires and cables and their accessories. He was born in Rochester, Ohio., December 22, 1857 and at first was connected with Sanborn and Warner, who operated under territorial contracts with the Washburn & Moon Mfg. Co.; upon their expiration in 1891 he was regularly connected with the latter company as Southern sales agent, for the states of Texas, Louisiana and Mississippi and the Republic of Mexico. In 1897 he was transferred to Chicago, in charge of city sales, until the Washburn & Moon Co., was absorbed by the American Steel & Wire Co., for which company he later attended the Paris Exposition as a representaive in 1900, and was subsequently connected with its Chicago office as salesman and expert in the rail bond department. In 1902 he joined the forces of the western sales department of the Standard Underground Cable Company under Mr. J. R. Wiley in Chicago, where he continued until January 1st, 1905, when the St. Louis office as established under Mr. Pietzcker's charge. Mr. Pietzcker is a member of various organizations, including among others the Missouri Athletic Club, Midland Valley Country Club, St. Louis Amateur Athletic Club, Engineers' Club, League of Electrical Interests; he is also a Mason and a Shriner; member of the Knights of Pythias, Knights of Honor, an associate member American Society Mechanical Engineers and American Society of Electrical Engineers, and member of the Jovian Order.

Mr. W. M. Rogers, formerly chief clerk and assistant to Mr. Wiley at Chicago, has been appointed assistant western sales manager with headquarters at Chicago. Mr. Rogers has been connected with the Chicago office of the company since December, 1900, and is already well known personally to very many of the company's customers in that territory. Mr. R. C. Houck, who has been appointed assistant southwestern sales manager with headquarters at St. Louis, has been connected with that office of the company since its organization in 1905, during which time he has represented the company as a salesman throughout its extended territory in the southwest. Mr. E. E. Woodbury is added to the selling force of the St. Louis office and is transferred for that purpose from the general sales department of the company at Pittsburgh, with which he has been connected for the past six years.

These changes in the organization of the Standard Underground Cable Company are due to the death last fall of Mr. J. B. Wiley, who for nearly twenty years was western manager at Chicago.

OBITUARY.

EDWIN EMERSON NOLAN, head of the materials disposition department of the Westinghouse Electric & Mfg. Company, East Pittsburgh, Pa., died at his home, 517 Center St., Wilkinsburg, Pa., on Tuesday January 13th. Mr. Nolan began work with the Westinghouse Electric Company in 1887, just about the time it began operations on Garrison Alley in the city of Pittsburgh He was subsequently made superintendent of the Allegheny factory of the company and as such had charge of building the first alternating-current generators for the Niagara plant, an installation which afterwards became famous throughout the world. He retained his position until the factory was concerted into a foundry.

In 1898 Mr. Nolan was sent by the Westinghouse Electric & Mfg. Company to France to establish a factory at Havre, in which position he remained until 1902. At this time he returned to the United States, and on account of his familiarity with Westinghouse apparatus was placed in charge of the materials department, a position which he held until his death. Mr. Nolan received his early education in Mexico, and from his sojourn among the foreign population acquired a ready speaking knowledge of several foreign languages which made his services unusually valuable to the company in dealing with its numerous foreign interests. Mr. Nolan was a mechanical engineer and an inventor of considerable ability, one of his inventions being now in use on the modern street railway motor as manufactured by the Westinghouse Company.

INDUSTRIAL ITEMS.

THE ELECTRICAL TESTING LABORATORIES of 80th St., and East End Ave., New York City, announces several changes in its official and executive staff. The present organization is made up as follows: J. W. Lieb, Jr., president; Clayton H. Sharp, vice-president; Preston S. Miller, Secretary, and Jos. Williams treasurer, with Preston S. Millar, general manager; Clayton H. Sharp, technical director, and F. M. Farmer chief engineer.

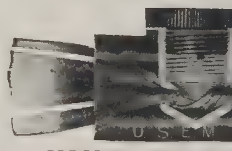
THE LUX MANUFACTURING COMPANY, after February 1st, 1914, will be located in the Factory Terminal building, Hoboken, N. J. Both factory and general offices will be located at this address, which is opposite 23rd St., Manhattan. The Company has in the past been located at 50 to 54 Grove St., New York City. Through this move larger and more convenient quarters are available in a new ten-story building.

THE CHATTANOOGA MANUFACTURERS' ASSOCIATION has established a permanent exhibit of Chattanooga made goods with special means used to demonstrate these products. The exhibit is housed in a four-story building 50 by 110 feet deep, with a floor space used for exhibits of more than 12,500 square feet. The exhibits are those of 130 of the 286 manufacturing organizations in the city, representing a capital of $35,000,000. Among the exhibitors are the Tennessee Water Power Company and the Chattanooga Armature Works.

THE CUTTER ELECTRICAL AND MFG. CO., of Philadelphia, Pa., manufacturers of I-T-E circuit breakers, announces the opening of a new branch office in Indianapolis, Ind., under the management of Linn O. Morrow. The territory served from this office will include Southern Indiana and Illinois, Kentucky, Tennessee and Missouri. The office will be under the supervision of H. F. Darby, Jr., district manager at Chicago.

THE UNITED STATES LIGHT AND HEATING CO., Niagara Falls, N Y., has changed the location of its New York City branch sales office from 30 Church St., to 210 West 50th St. This change brings the New York service station and sales office in the same building The general sales offices of the company will still be located at 30 Church St.

THE SOUTHERN FERRO CONCRETE CO., engineers and contractors, Atlanta, Ga., have been awarded the general contract for the erection and completion of the Columbus Hotel, Columbus, Ga., including the reinforced concrete skeleton frame, elevators, plumbing, heating, electrical work, fixtures, refrigeration plant, kitchen equipment, etc. The building will be ten stories high and will cost $200,000. Those interested in furnishing sub-bids should address Southern Ferro Concrete Co., Trust Co., of Georgia building, Atlanta, Ga.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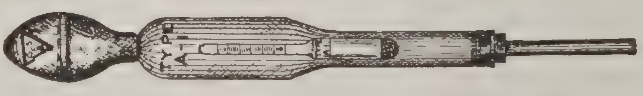
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Is a Power Monopoly Possible?

In the January issue of *Electrical Engineering,* we published the opinion and comment of a reader, on the regulation of the water power business as a monopoly, under the heading of "The Power Trust and Public Distrust." The heading was considered appropriate because it embodied two popular phrases used in connection with a discussion of water power regulation, and it has served the purpose intended, namely, to call in comments from those who object to the use of these terms in this connection. We thus take this opportunity to present our viewpoint of the situation and call attention to a few pertinent reasons for the coining of these terms and to give their true significance or lack of such.

First of all, we ask, "Is a power monopoly possible?" Second, "Why should the public be distrustful, and in fact, is there a logical reason for such to exist among thinking individuals who know anything about the water power business or any other phase of public utility service?" The first question is decidedly debatable—one involving the much discussed ideas of conservation and the exploitation of natural resources by private capital. Suffice it is to say that such discussions have proceeded far enough to cause those on both sides to recognize that competition in the rendering of public utility services, including steam railway, electric traction, gas, water, electric light and power, telephone and telegraph service, is ruinous to quality of such service and does not properly regulate it. Further, competition causes waste of capital through duplication of plants, duplication of transmission and distribution lines, duplication of office facilities and those who take care of such details, besides the carrying in stations of useless and non-productive machinery. In a restricted field, such as served by the majority of public service corporations, if such a waste is permitted to go on, it can only mean one thing—the crippling of a meritorious industry and the suppressing of a notable achievement thus far gained in the United States, as in no other country, namely, the enterprise and courage of energetic men who have demonstrated that the resources on which they work can be made available to each and every citizen at a fair price, if not handicapped by unfair policies and unfair laws.

On account of this situation, utilities are now being recognized as so-called "natural monopolies." The use of the term monopoly we believe is unfair in this case in view of the prejudice now existing in the lay-mind of the term in its narrow sense and the proneness of unscrupulous and unthinking politicians to grab at this straw and keep alive such a feeling at times when it can serve their selfish ends. A better substitute for the term "monopoly" in this case would be "privilege"—privilege by virtue of available capital, available ability, and available enterprise to render a service that will better the conditions under which the general public works and lives, and to produce a commodity that can be contracted for or not, as one's judgment may dictate, the contracting for or not causing no obligation or tax that is beyond individual control and governed by popular clamor.

Our correspondent makes the statement that the water powers of this country are going to be monopolized. He seems to think that ten financial interests will eventually gobble up every water fall and string a network of lines that will criss-cross this country until every electric light and power user has been caught by the gills, when this net will be lifted to allow some unscrupulous giant to go through the pockets of the victims for the change that may be available. This we are sure is an unfortunate impression to gain from the trend of development by public utilities and the large benefits that have been possible only through such developments. We do not propose to favor such an idea with recognition by an argument further than to call attention to the fact that during the past two decades, with consolidations of electrical organizations increasing in number and holding organizations gradually growing in strength and consequently in usefulness, the price of service from public utilities has been continually reduced, in the face of higher prices for labor, greater demand for high salaried and skilled specialists, greater cost of materials, and increasing demands of the public per Kw-hour served. The popular idea that formerly immense dividends were earned on capital invested is entirely at fault and the only reason that utilities are now able to satisfy their investors, is on account of their ability to show that with an increased knowledge of the business has come an ability to render a better quality of service at less cost per unit and an ability to use all equipment more efficiently through studying the nature of demands and the diversity of loads. With this in view the cost of service has been better standardized and the rate due to particular volumes of business been adjusted to that deserved. With the development of our water power systems, connecting as they do many large and small towns, the solution of this situation has been largely brought about, for it has been learned that the nature of the demands of all are sufficiently different to build up a load with favorable characteristics as regards reducing and properly distributing the cost of individual service.

Our correspondent also takes up governmental regulation showing it to be a punishment for inordinate profits and improper exploitation methods. Without a question, proper regulation of utilities by public service commissions has become one of the greatest assets to the former that has yet come to them. The activity of commissions properly made up, such as the Wisconsin Commission, has brought to light and given publicity to certain features of public service operation that the public never dreamed of nor would have believed if made known by the utilities themselves. Such commissions have, through investigation, made known certain facts in regard to the cost of serving aggregate and individual demands and it is certain that eventually they are to be of the greatest help in establishing rates suited to the varying conditions throughout this country. The commission of the proper type has caused and will as time wears on, continue to cause the unscrupulous politician to be very cautious in his remarks and attacks on public utilities. Last and most important, public service commissions of the right sort are now recognized as a court of final settlement of differences between both public and utility, where the decision is in favor of the one most deserving, based upon actual facts that can be produced. On account of these features, regulation by public service commission is now not considered a punishment, but is heartily indorsed and welcomed by every progressive public service corporation and few do not deserve a place in this class.

As to the situation created by government regulation and operation, such as that existing in the territory controlled by the Ontario Hydro-Electric Power Commission, we are particularly fortunate to be able to present here a few remarks in answer to the comments of our correspondent, from one whose name is well known to our readers as the author and engineer who came to the rescue and was brave enough to assist in the warding off of a similar calamity in the state of New York in 1912. We quote Reginald Pelham Bolton in what follows:

> "Regulated monopoly is the order of the day. This principle is radically opposite to the Canadian principle of unregulated and destructive competition, duplicating investments and constituting economic waste. It cannot be called 'proper governmental regulation.' A power monopoly is not possible, as long as coal, oil, gas, peat or other fuels are available. The dubious economic value of water power is little known and its dependence on steam as an auxiliary and means of continuity is not properly comprehended. The cost of developments of water power is excessive, and even though it may look reasonable per unit installed, such units are not of the same relative value as a steam unit, which is flexible in energy consumption, and can be operated to parallel the fluctuations of demand for energy. To create a power monopoly it would be necessary to corner all the fuels, before it could become effective. Existing power companies are monopolies only to the extent of their franchise rights, and these are readily regulated by suitable legislation.
>
> "The best way to develop any water power that is economically advantageous and evidence is lacking that most of them are so,—is to permit private capital to do it and thus likewise take the chances of its being of real value. A state system of operation will be more expensive, both in installation and in operation. If state owned, then a suitable value can be placed on the water, but this should be variable, based on relative value of other sources of energy. A waterfall in any district where fuel prices are high may be a source of profit and pay a relatively high price for the water rights, but if fuel should be found nearby, its whole value would disappear.
>
> "The instance of a local steam power company buying the output of a hydro-electric plant as stated by a correspondent in the January issue of Electrical Engineering does not prove anything except that the continuity of service in the city is of more value than the hydro energy, which is undependable without the steam plant. The service of Toronto, in Canada, has been down and out, sometimes for a whole day at a time, and the only service maintained was that of the steam power plant of the Toronto Electric Company.
>
> "People are easily deceived by low prices per annual horse power, not knowing that when translated into the actual usage per kilowatt hour, it is greatly enhanced. The apparent low prices prevailing in Ontario are very deceptive in this way. Average prices per kilowatt hour of usage are very similar in Toronto and Albany, N. Y., and some classes of service are cheaper in the latter city.
>
> "As far as the operations of the Hydro-Electric Power Commission of Ontario have gone, little has been effected that could not have been done by proper regulation, without any expenditure of public capital. Notwithstanding the arbitrary and confiscatory powers of the commission, it has not built or even purchased one water power development, because it found it did not pay to do so. They are getting low prices for raw energy from corporations which sunk enormous excess costs in developments, without a visible market for the output. The price paid for its Niagara service of $9.45 per horsepower per year is only possible because the power station has other customers. The estimate of a 100,000 horsepower plant at Niagara producing an annual horsepower for $4.95 was attainable only by ignoring palpable facts. The cost of construction could not be less than $120 per horsepower installed, and even on 80 per cent load factor, $150 per horsepower of output. The fixed charges alone would be in excess of 8 per cent., or $12 per horsepower.
>
> "As to the results quoted by your correspondent, the Toronto Company has been able to make good because its bonded indebtedness was only one-fifth of its municipal competitors. It has unloaded on the other system all the smallest and least paying class of consumers, and built up the best class of large load factor custom. The reduction in Ottawa of domestic rates from 15 cents to 7 cents was not brought about by the Hydro-Electric Commission, but as a result of competitive business between the Ottawa Electric Company and the Consumers Lighting Company, prior to the advent of the commission. After the municipality

started on its course of trading in electricity, it bought up the Consumers' system and the rates remained the same for several years.

"In Winnipeg, the reduction from the 20 cent domestic rate was made by the Winnipeg Electric Railway Company, when it constructed its own hydro-electric plant as an auxiliary to its steam plant. Private lighting and heating probably mean a loss to both systems at present, though the electric load is in the better position because it operates a railway and also has a large steam auxiliary. The company paid 11.5 per cent dividends in 1911 as your correspondent infers, but prior to that date paid much less, and in the early days when it was a large factor in the upbuilding of Winnipeg, it paid nothing at all for nine years, and only 5 per cent for six years. It has averaged less than 8 per cent over its existence, which is not excessive in that region. It has meantime paid to the city in franchise taxes, etc., over half a million dollars. The Toronto Railway Company has paid the City in fifteen years $6,815,414, and has paid in dividends during the same period $6,386,884.

"These facts do not find their way into conservationnsts' theories or into Commissions' reports. The Hydro-Electric Conservation scare of power monopoly is a bug-a-boo,—an explodable bubble."

As to the second question raised, namely, the reason for public distrust in matters pertaining to the management of public utilities, such exists largely on account of public ignorance of technical considerations in connection therewith and the misused of such considerations through generalities which have created overestimates possibilities in the lay-mind, especially as regards the cost of water power. It is not generally known that water power is not the same as electrical power, and that between the water wheel and customer of the water power company, there are a number of obstacles each consuming a part of the energy represented by the falling water, so that in many cases not over one-third of the capacity of the water wheels can be sold as kilowatt hours. In addition too little is known generally about costs of dams, cost of power houses, cost of right of ways and incalculable costs on account of real and imaginary damages to properties surrounding developments, the costs of transmitting energy on account of mechanical requirements, such as towers, insulators, switches, switch houses, etc., before the customers meter is reached. The answer to the question, "Why has such information been so carefully guarded and little legitimate publicity given in answer to the many glaring statements about cheap water power?" will likewise be one answer to the reason for public distrust as it now exists.

Distrust has again been created by the position the federal government has taken on the matter of conservation. Granting the sincerity of those agitating and supporting the present policy, it is certain that the true merits of the situation have not as yet been considered from the standpoint of securing for the general public the greatest good that is possible from water power sites. The effect of the present policy is now evident in the west where the suspension of water power development has had its expected results, not only upon communities depending upon such development, but on the entire manufacturing interests of the country, to say nothing about the withdrawing of capital and the effect of temporary failure of the worthy promoters and builders on those who are to follow. We submit to the decision of fair minded readers, the need of some united action against the policy whereby a government is permitted to grant a permit to install a hydro-electric plant costing millions of dollars, to use the stream flow for a restricted period and encouraged to stretch transmission lines in all directions and then as a penalty for this enterprise, reserve the right to do anything that may seem fit at the expiration of the permit. Such action may take the form of forcing the company to remove its plant, which would mean to abandon it, or renew the permit at no previously stated rate, but one which may seem advisable in the minds of federal and state officers who may be in power at the time the contingency arises. Such officials can know little about the business history of the case and are usually men who have accomplished nothing in this world except in politics, and could neither devise such a project as required to legislate against, nor, on account of ability and judgment, raise a dollar toward it. This sort of a policy, supported by our government, we believe largely responsible for the public district that now exists in the managements of the affairs of public utilities, and especially those companies who are spending millions each year in the development of water powers at a tremendous risk.

The following remarks are quoted from a communication from a Southern central station manager who has had an extensive experience in the West and other parts of the country as well, and is a student of electrical development in a broad way:

"When I first glanced at the article entitled "The Power Trust and Public Distrust," in your January issue, I supposed it was headed in this manner for the purpose of attracting attention and that some most important and convincing facts or reviews would be found in the article. I did not find this to be the case, however, and was disappointed. I do not know who is responsible for the title on page three, but believe it is a misleading one. I do not believe that either the title or the article could be looked upon with sufficient seriousness by anyone really interested in this subject to be damaging to the business of hydro-electric development, although the article might give unthinking persons false impressions and erroneous bases for argument, but I take it that unthinking persons do not read Electrical Engineering carefully, if at all, and that the article has therefore probably done no material harm.

"I am not in a position to answer the article very much in detail because I believe this would require a careful study of the references mentioned and as they include an annual report of the New York Conservation Congress the work would be quite laborous. I feel satisfied, however, that careful reading of these reports would produce as many statistical facts opposed to your correspondent's conclusions as in favor of them. It would not be very difficult to show that your correspondent was mistaken in some of his deductions both from an engineering and financial standpoint. For instance, read carefully the following sentence appearing near the bottom of the second column on page three: "One of the first acts after thoroughly studying the situation was to contract to buy some 20,000 or 30,000 horsepower from The Ontario Power Company of Niagara Falls at the handsome price of from $9.00 to $10.00 per horsepower per year. Before doing this its (The Hydro-Electric Power Commission of Ontario) engineers estimated that a 100,000 horsepower plant could be built at Niagara to produce a horsepower per year at the cost of $4.95." If the engineers were correct why did the Commission not build a plant and save between $4.00 and $5.00 per horsepower per year. The statement just preceding was to the effect that it had the authority to do so. The exact wording being, "It might build power houses." Probably an investigator, after study of the reports, could find an entirely reasonable explanation for this and other apparent inconsistencies.

"Your correspondent says in opening his article that public conviction is slowly but surely crystalizing about the idea of Government regulation. I believe he is several laps behind the times. Public conviction is not crystalizing, it has already crystalized; and Government regulation of inter-state water power business is as evident in its effects upon the development of the business today as though there were a special inter-state hydro-electric commission with as much power over transmission companies as the Inter-State Commerce Commission has over railroad companies. As evidence of this fact one has but to look in the records of Congressional activities during the past five years to find a multitude of legislative events directly influencing decisions on the part of investors to develop water powers. Until now there has not been any regulation of rates by the Government for the very plausible reason, that no rates charged by water power companies have until now resulted in undue returns on the investments. The rates have therefore been too low, and regulation is not usually exercised until they become too high. It would not take the National government long to delegate the necessary authority to some existing commission, or to create a new commission with the authority, if the fact could be established, that any water power company was earning too much money.

"With reference to the mention of the fifth National Conservation Congress, I would call attention to the speech of Honorable

Is a Power Monopoly Possible?

Albert Johnson of the State of Washington, reported in the Congressional Record as of Saturday, November 2nd, 1913. Mr. Johnson predicts disruption for this body, not because the basic principles on which it was established are wrong, but because its machinery has become clogged with the political activities of self interested persons. One thing is very evident in my mind from his remarks, and that is that the regulation of water powers by prohibition has crystalized to the point in our National government where the individual voter and tax payer is being made to suffer far more than he could have been made to suffer by an unhampered and unregulated development by private interests of those water powers which still lie idle.

"Your correspondent speaks of inordinate profits as though they were every day occurences with public utilities. He will find it very difficult to point out any such in the water power business. He winds up his article with a very strong statement. It is that co-operation between hydro-electric companies is not as expensive as competition. This is becoming more generally known to the public every day, and the time is not far off when the ultimate consumer, who is the one that pays for expensive and wasteful management, will insist that competition in public utility work be prohibited, and that the regulation of public utilities extend to the point of insisting upon local steam power generating companies buying hydro-electric generated and transmitted power. The consumer will insist through his regulating bodies (national in the case of interstate business and state in the case of intra-state business) upon being given the benefit of the diversification of water sheds through inter-connection of separate transmission systems. He will insist upon stream-flow regulations looking to efficient operation of power plants, which in itself, will improve the navigability of the rivers. He will insist that transmission companies be given, not only the right of eminent domain, but that juries shall award not more than fair compensation in case of lands being taken for the purpose of constructing lines and dams. In other words, before long the ultimate consumer will insist upon what your correspondent seems to conjure up as a menace; namely, the monopolizing of the power business for the benefit of the consumer through efficient joint management made possible by fair regulation and protection.

A reader who has visited Toronto, Canada, and observed some of the conditions, says in regard to the Canadian situation:

"There has never been a more unfair piece of legislation than the creation of the Canadian Hydro-Electric Commission which was given the right, as your correspondent says, to require any power company to open its books, plants, contracts, etc., for inspection, and after obtaining all the figures and facts necessary, could institute a ruinous competition with no fear of bankruptcy the further right to institute a ruinous competition with no fear of bankruptcy to deter it, backed as it was by the resources of Canada. Regulation is all right, but no man without a streak of yellow and with any sense of justice would defend such an iniquitous National policy. In Toronto, he exultantly declares, the old company is doing 30 per cent more business at half the rate. Isn't that glorious? It reminds me of the argument of some of our friends who have figured out that we would make more money if we would give them a half rate for street car service, arguing that they would ride more, in fact that they would ride both ways each day, while with the full rate they only ride one way.

"I am not in a position to verify your correspondent's statements on the Winnipeg fight between private and municipal ownership, nor am I advised as to the accuracy of his figures, but if the City of Winnipeg can transmit electricity 77 miles and sell it for retail residence lighting and cooking at 2.4 and 9 cents per K. W. H., respectively, and get away with it, the organization is a fine one. Perhaps they don't do this, but certainly we are lead to infer it.

"Altogether your correspondent's 'homily', although he would have us infer that regulation is his text, is more of a demagogic appeal to prejudice and an attempted boost for competition than anything else. He must have the distorted views of the political demagogue, inasmuch as the best thought of today is in favor of the natural monopoly theory which protects the utility company, so long as it gives adequate service at fair rates. Perhaps the Canadian companies were not doing this but the remedy if this is the case, should not have been confiscation."

Southern Train to Philadelphia Convention.

Arrangements are now being made so that Southern delegates to the Philadelphia N. E. L. A. convention can attend in a body, as has been the custom of other sections of the country. The success of the arrangements made for the Chicago Convention last year makes it desirable that a special train be regularly run from the South, and that the details in connection with same be made known at an early date. At a recent meeting of the executive committee of the N. E. L. A., Southeastern Section, President T. W. Peters, of Columbus, Ga., appointed A. H. Sikes, sales manager of the Athens Railway & Electric Company, Athens, Ga., as transportation manager for the Section to make arrangements for the national convention and the Southeastern Section convention in August as well.

Mr. Sikes advises that while the national convention is now three months off, being set for the first week in June, he has already placed the matter before the National Transportation Committee, and is at work on a publicity campaign among association members and passenger agents throughout the South, with the idea of securing schedules and junction points which will best enable our members to get together at a central point from which the specail train can start. This point, from present indications, will be Atlanta. One member from each state is to be selected as a committee on final arrangements to carry out the details of the plan.

Inasmuch as the usual Boston and New York trains will not be run this year on account of the regular accommodations that already exist between Philadelphia and these points, the Southern Transportation Committee will receive considerable help from the National Transportation Committee, which, with the individual aid of all interested, will make a special train not only a convenience, but a feature in connection with Southern representation at future conventions. Further details of arrangements will be announced in these columns as they are decided upon.

Convention of Southern Section N. E. L. A.

As already announced in these columns, the annual convention of the Southeastern Section of the National Electric Light Association will be held at the Isle of Palms, near Charleston, S. C., August 19 to 21. The publicity committee, of which W. W. Fuller, chief engineer and general superintendent of the Charleston Isle of Palms Traction Company, is chairman, has already started an active campaign in which all features of the coming convention will be made known. While the organizers of the Southeastern Section are proud of the results already accomplished and the reputation established that its convention is a working one, the necessary entertainment features and exhibits by Class D members are in no way slighted, as the plans for the coming convention indicate. In regard to these Mr. Fuller says:

"The convention dates fall on Wednesday, Thursday and Friday, which will permit members and their families staying over Saturday and Sunday at the Isle of Palms, returning home on Sunday night or Monday of the following week. Sunday at the Isle of Palms is one of the 'large' days, with special attractions being provided. It is expected that during this season a high class vaudeville will be provided for the members in addition to the usual attractions—surf bathing, boating, fishing, dancing in the large pavilion, music by Metz's Military Band, board walk, cafe, hotel and club accommodations.

"The Southeastern Section is arranging plans for a line of exhibits by the electrical manufacturing companies. Mr. C. D. Flanigen, vice-president of the Athens Railway & Electric Company, is chairman of the committee on exhibits, and is at this time arranging for such exhibits as should be of interest and benefit to members."

Second Hydroelectric Development on the Ocoee River by Tennessee Power Co.

Section 2. Power House Equipment and Arrangement of Ocoee Station No. 2.

In Section No. 1 of this article published in the February issue of *Electrical Engineering*, the hydraulic features of the Ocoee Development No. 2 were presented. In what follows the electrical details are discussed.

The power house is 120 ft. 4 inches long by 77 ft. 8¼ inches wide. As shown in the section view, the power house equipment is practically on one level except the lightning arresters which are in a gallery above the low tension bus structure. By this arrangement the generator floor is the lowest level with the transformers six inches higher and the high tension switches in the rear two-feet above the floor level of the transformers with all apparatus except the lightning arresters practically on one level, the height of the building is reduced and consequently a great saving in cost effected. By having the rear of the building on a higher level a saving was made in the amount of excavation required for the power house foundation. This excavation was from solid rock and even as it is built, required 10,000 cu. yards of excavation from the solid rock. The section view shows the way the penstocks enter the building and shows that excavation was carried just deep enough to give a location for the penstocks.

The roof of the building is 50 ft. above the generator floor. The building is constructed entirely of brick and steel on the concrete foundation. The roof is of formed reinforced concrete slabs made and shipped in proper sizes to fit the roof steel. These slabs are held down by their own weight only. The joints between the slabs are poured with a compound for sealing. Over these slabs tar paper is placed and then a coating of tar and gravel. At the south end of the building, in an annex to the main building, the battery room, office and toilets are located. This addition is built on a level eight feet above the main power house floor. The location of the office permits of the whole power house floor being overlooked from the office through the windows in the wall between the office and the main building. A retaining wall runs the length of the building at the rear preventing slides against the power house wall. This is necessary as the back fill of dirt over the penstock might slip at any time and be precipitated against the rear power house wall.

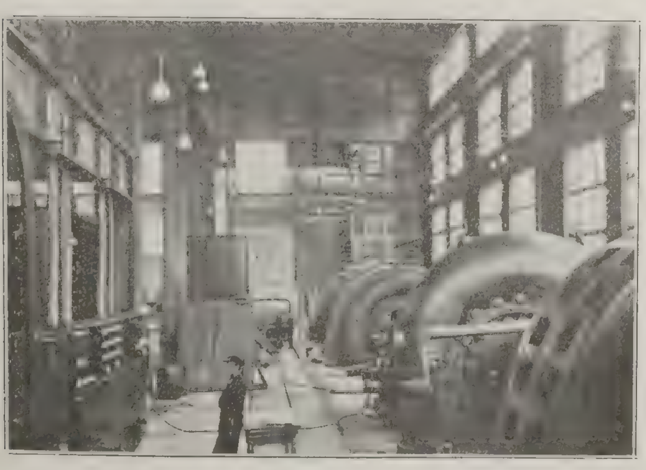


Fig. 1. Generating Units and Switchboard at Ocoee Station No. 2.

The north wall of the building instead of being of brick is of reinforced plaster. This provision is made because of the fact that the installation of the third water wheel at this end of the building will require that this wall be removed. The flume capacity is designed for three units and also provisions are made for the third penstock at the concrete flume outlet. Part of the rock excavation for the third wheel has been made so that in the future when the demand for power requires this installation, it can be made without much difficulty.

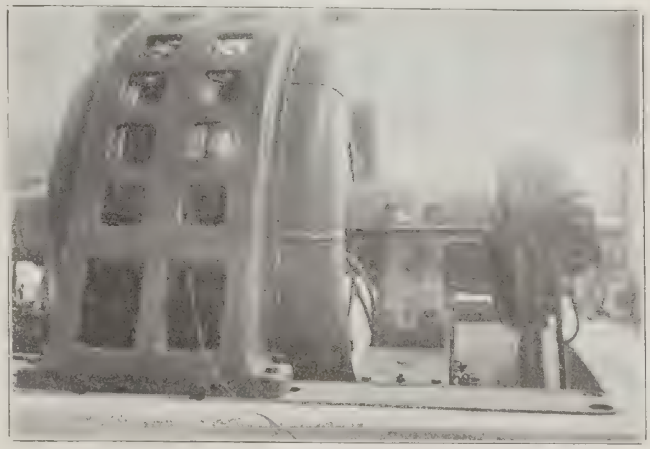


Fig. 2. Type of Generating Unit at No. 2 Station.

The sections of the power house as given show that the main generator floor occupies one half of the building next to the river and has a crane of sufficient capacity to lift the heaviest piece of apparatus. The half of the building away from the river contains the transformer and high tension oil switches as shown. The transformers are mounted on trucks which roll at right angles to the length of the building. A transformer can be rolled out of its bay to the main floor where it can be lifted by the crane on the main track which runs the length of the building opposite the transformer bays. The crane, while rated at thirty tons, is geared low so that the fifty-nine ton rotors of the generators can be handled with ease. The top of the crane rail is 38 ft. 10 inches from the generator floor level and gives sufficient head room to lift the core out of the transformers. The plan of the building shows the general arrangement of the apparatus. The two horizontal shaft water wheels and generators have their shafts parallel to the river and are located on the river side of the power house. The switchboard is located near generator No. 1. At the rear of the switchboard are the low tension switches and bus structure with the low tension disconnecting switches. The bus structure is shown in detail in the sketch. The main transformers are located on their bays almost opposite the generators and the 120,000 volt oil switches near the rear wall. The gallery, shown in the section, contains the four lightning arresters, tanks and the transfer device, the main generator rheostats and field discharge resistances and the auxiliary power transformers, 6,600 volts to 220/110, 3-phase. The lightning arrester hour gaps are mounted on the roof and operated by a rod through the

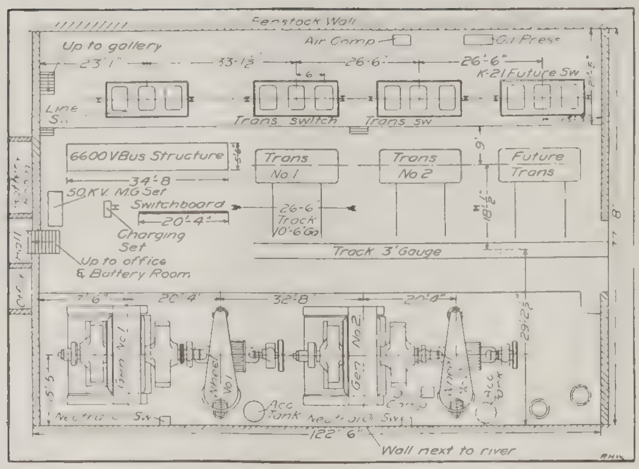


FIG. 3. PLAN SHOWING ARRANGEMENT OF STATION APPARATUS.

roof to the gallery floor. The leads to the horn gap from the lightning arresters and also the main line leads, go out through 120,000 volt porcelain, oil filled roof bushings. These bushings are 6 ft. 6-in. from lower porcelain lead to oil reservoir on top. The oil reservoir has a gauge to show oil level. The line disconnecting switch is of the horn gap type operated by a rod going through the roof and to the main floor at the rear of the line switch.

The oil for the transformers and oil switches will be stored in tanks provided for the purpose. There is one tank provided for storage of oil for lightning arresters and oil switches, with a capacity of 2,700 gallons. The tank for the storage of transformer oil has a capacity of 14,000 gallons. These tanks are located outside the present main building in the place where the future unit will go. They are located in concrete below the level of the floor extension and each is provided with a manhole so that the tanks can be cleaned on the inside. From the tanks the oil can be pumped through the filter press to the transformers and oil switch tanks. The transformers and oil switch tanks have drain pipes to the main 6-in. drain which leads to both oil tanks and also to the tail race.

WATER WHEELS AND GENERATORS.

The water wheels complete with governors were supplied by the I. P. Morris Company. These wheels are of the horizontal shaft, single runner, double discharge type supplied with bronze Francis type runners and cast iron volute casings. The operating mechanism consists of cast steel guide vanes with fulcrum pin extensions, connected through levers and links to an operating ring. This ring is connected to an operating cylinder mounted upon the casing. Each wheel is provided with a friction brake located on the end of the turbine shaft away from the generator and with a bursting valve and speed limiting device.

The wheels are furnished with intake reducer pipe to reduce from an 8 ft. penstock diameter to 5 ft. 8-in. diameter opening of the wheel casing. The draft tubes have a discharge opening 6.5 ft. in diameter located 22 ft. 9-in. below the axis of the shaft. The shaft as shown has a center elevation of 851.5. Each wheel is equipped with an oil operated governor belted to the shaft. Each governor is equipped with an electric motor for speed control and load adjustment from the switchboard. The governor operation by means of a four-way valve, admits oil under pressure to one end or the other of the operating cylinder and exhausts oil from the other end of the cylinder. The oil pressure is supplied by an oil pump furnished with each machine and belted to the shaft. This pump forces the oil into the accumulator tank under proper pressure. When this pressure is reached a pressure relief allows the circulation of the oil through the pump and relieves the work required from the pump and prevents excess pressure in the accumulator tank. Each wheel also has a low pressure tank into which the oil is exhausted.

The rating of the two water wheels is 10,000 Hp. each at an effective head of 250 ft. when running at 360 revolutions per minute. The efficiency of each wheel at 360 Rpm. and 250 ft. head at various loads was guaranteed as follows:

Load	Efficiency
10,000 Hp.	.84
9,100 Hp.	.87
7,500 Hp.	.84
5,000 Hp.	.75

The load as guaranteed is at the coupling of the water wheel. The power as stated and also the maximum efficiency of 87 per cent were guaranteed and unless these conditions were reached necessary changes were to be made to meet the conditions.

The generators are horizontal shaft machines with a rated speed of 360 rpm., the full rating being A T B—20

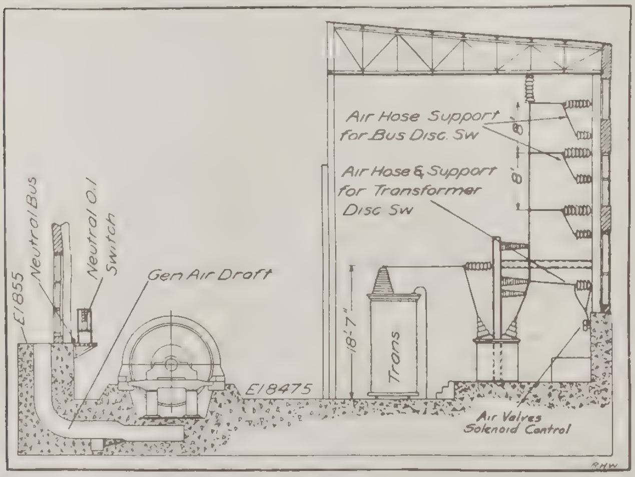

Air Hose Support for Bus Disc. Sw
Air Hose & Support for Transformer Disc Sw
8'
8'
Neutral Bus
Neutral O.I. Switch
Gen Air Draft
El 855
18'7"
Trans
El 847.5
Air Valves Solenoid Control

FIG. 4. SECTION THROUGH STATION SHOWING HIGH TENSION SWITCHES AND AIR-OPERATED DISCONNECTING SWITCHES.

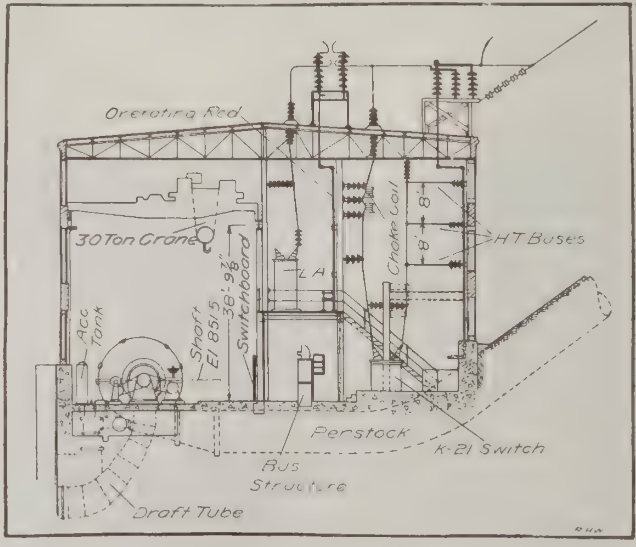


FIG. 5. SECTION THROUGH WATER-WHEEL SHOWING BUS STRUCTURE, LIGHTNING ARRESTERS, HIGH TENSION BUSES AND OUTGOING LINE.

poles, 9,375 Kva., 360 Rpm., 6,600 volts, 3-phase, 60-cycles. The neutral of each machine is brought out and grounded through a single-pole oil switch. This rating at 9,375 Kva. is for a temperature rise of 40 degrees C, after a continuous run until temperatures are constant. Each machine is guaranteed for a two-hour overload of 25 per cent, with a temperature rise not exceeding 55 degrees C. Since the 10,000 Hp. of the water wheel is 7,460 Kw. delivered to the generator, the generator normal load rating is 7,500 Kw. at 80 per cent power factor with a provision for a two-hour overload of 25 per cent at the same power factor. The efficiencies of these machines as guaranteed are:

			Efficiency		
Kva.	P. F.	Kw.	Full load	¾ load	½ load
9,375	0.8	7,500	95.5	94.5	92.5
9,375	1.0	9,375	96.5	95.5	94.

These efficiencies as guaranteed include friction and windage of the machine and all electrical losses except in the field rheostat. The generator end shields are in solid segments. The cooling air is taken from the outside of the building through an air shaft. This air shaft enters the bottom of the generator pit. The heated air is discharged into the room. The bearings of the generator are oil cooled by means of rings, each generator having two bearings.

EXCITERS.

Each generator has its own exciter with the exciter armature directly on the generator shaft, on the shaft extension at the outer bearing. These exciters are 6-pole, 120 Kw., 125/125 volts compound wound interpole machines. Each exciter feeds an exciter bus at the switch board so that each exciter can be used with both machines. These exciters are designed for operation with a Tirrill Regulator. The excitation required by each generator at 7,500 Kw. and 80 per cent power factor is about 60 Kw., or half the exciter capacity, so that each exciter is capable of exciting both main generators under overload conditions at 0.8 P. F. allowing for the regular 25 per cent overload on the exciters.

TRANSFORMERS.

There are two 3-phase transformers in the initial installation, one for each generator. Each transformer has the same capacity as the generators, with the same overload guaranteed. These transformers are oil insulated, water cooled with the following rating: W. C. T., 60-cycle, 9,375 Kva., primary volts 66,000/120,000, secondary volts 6,600—3-phase. Taps are provided on the primary to give 64,000 / 62,000; 60,000 / 115,000 / 110,000 / 105,000 / 100,000 / 95,000 volts with full capacity of the transformer.

The efficiency of these transformers is guaranteed as follows at 100% P. F., with regulation at full load and power factor 1.0 and 0.8 as shown:

Load	1.25 full	¾	½	¼	Power factor	1.00	0.8
Eff....	98.4	98.4	98.2	97.8	96.2 Regulation....	1%	5%

The transformers are delta connected on the high tension side and are now operating at 66,000 volts. They are of shell type in rectangular shaped tanks mounted on trucks so as to be moved at right angles to the long axis of the transformer. Each transformer is also provided with a quick-opening valve so that the oil can be drained from the transformer in case of trouble. A thermometer with a bell alarm attachment, to ring when the temperature reaches 75 degrees C., is provided with each transformer. A relief opening is provided in the cover by having a manhole, on which the cover is not bolted, but simply placed in position and held by its own weight.

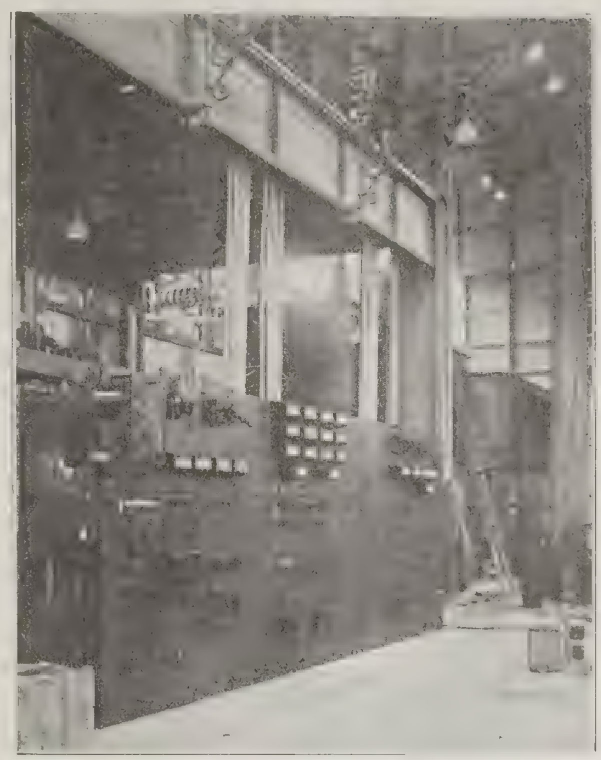


Fig. 6. Switchboard at No. 2 Station.

OIL SWITCHES.

The low tension generator and transformer oil switches are type H-3, motor operated, 3-pole and of 1,200 amp. capacity. The 6,600-volt switch for the station auxiliary is also H-3. but of 300 amps. capacity. These H-3 switches are all mounted in the concrete bus structure at the rear of the switchboard, as shown in the sketch. A section through the bus structure and H-3 switch is also shown. The neutral lead of each generator is connected to the ground bus through a single pole K-12 oil switch. This ground bus runs around the building on the concrete wall, and has connections to the oil switch and transformer tanks and to the generator. It is of 4/0 solid copper, except between the two neutral generator switches, where it is 750,000 c. m. stranded bare copper cable. This ground bus runs to a ground plate in the tail race.

The high tension switches are 3-pole, type K-21 for 120,000 volts. Each switch is solenoid operated, and each pole is mounted on a separate oil tank. The leads are oil-filled. Each high tension switch has a steel framework above, on which the insulators are mounted which support the high tension leads from the transformers to the oil switches and from the oil switches to the bus or disconnecting switches. These oil switches each have bushing type current transformers to operate relays located at the switch to trip under excessive overload. The current transformers are made ring-shaped and fit over the oil-filled lead, being bolted to the cast iron collar of the lead.

DISCONNECTING SWITCHES.

The low tension disconnecting switches are mounted in the concrete bus structure, as shown, and the high tension disconnecting switches for the transformers are mounted on the steel framework above the transformer oil switches.

These switches are designed for 120,000 volts and are air-operated. The air valve for operating each switch is solenoid controlled from the main switchboard. These air-operated switches are one of the interesting features of the station. An air compressor is installed for their operation, having air tanks and a pressure governor to open the motor circuit when the pressure reaches 90 pounds per square inch, and picks up again, starting the motor when the pressure drops to 80 pounds per square inch. The air hose going from the air valve to the switch is mounted on a separate 4-disc insulator, and the hose is long enough so that there is no leakage over the rubber hose. The bus supporting steel work is drilled for future bus disconnecting switches to be installed when the third unit is put in. These disconnecting switches will be air-operated and solenoid-controlled. With this provision, and with the roof outlets provided over No. 3 transformer bay, the second line can be brought out in the future, and the station can be operated with two lines at different voltages. The line disconnecting switches for the present outgoing lines are installed on the roof and are of the horn gap type.

STATION AUXILIARIES.

All power for station lighting, battery charging set, motor generator set for crane, air compressor and filter press is taken from two 75 Kw., 3-phase transformers located in the gallery. These transformers step down from 6,600 volts to 110/220. The transformers are controlled by an H-3, 300 amp. oil switch from the auxiliary panel. The air compressor motors, fitting press motor and the motors of the charging set and main 50 Kw. motor generator set are 220 volts, 3-phase. The 110-volt, 3-phase leads feed to one side of the double throw, triple pole switch of the induction motor of the 50 Kw. set for starting, and also to a triple pole, double throw switch for lighting, and also to supply power to the sump pumps. The lighting mains feed from the middle points of this switch. By throwing it one way the lights are fed from 110 volts A. C., and by throwing it in the other direction the lights are taken from the 125-volt D. C. generator of the 50 Kw. motor generator set. This generator supplies the power for the crane and the lights, as mentioned, and can also be thrown on the operating buses if the battery is not in condition.

The main lighting is fed from two panel boxes having separate leads to the switchboard and controlled by separate switches at the switchboard. One panel box feeds the generator side of the building, while the other feeds the transformer and high tension side. These boxes are located on a column at the end of the switchboard. Emergency lights are provided in front of the switchboard near the generators and in the high tension room, office and battery. They are taken direct from the switchboard through a relay with a no voltage release. Under normal operation this circuit is on the 110-volt supply from the auxiliary transformers. When this voltage fails the relay throws the emergency lights on the battery circuit. The lighting is by two lamp fixtures on each column in the generator room and over the main transformers using extensive Holophane reflectors on each 150 watt tungsten lamp. In the office, battery room and over the bus structure, a single lamp type of fixture is used with 60 watt tungsten lamps. Near each end of the high tension switches are two 60 watt lamps mounted on the steel disconnecting switch framework. On the rear wall and front wall, single lamp fixtures are used without shades or reflectors, while a complete circuit of lights is run on the high tension side above the buses along the roof trusses. All lights near the high tension lines are protected from static effect by wire guards. Near each machine a plug receptacle is installed for use in case of trouble when an extension light would be required.

LIGHTNING ARRESTERS ON ROOF.

As stated, the lightning arrestor is located in the gallery. It is of the four-tank type of General Electric design for 120,000-volt, non-grounded, 3-phase circuit. For 66,000-volt operation only half the number of trays are installed. The hour gaps are mounted on the roof and operated by a rod from the gallery.

SWITCHBOARD.

The switchboard consists of eleven slate panels. The arrangement of the panels from the end of the building next to the switchboard is: Swinging bracket, Tirrill regulator panel, 3 exciter panels, 3 generator and transformer panels, 1 high tension transformer and line panel, 1 auxiliary transformer and motor panel, 1 battery and charging set panel, 1 lighting and station auxiliary panel. The panels are each of 3 sections, the bottom section being 28 inches high and the others 31 inches high, so that height of switchboard is 90 inches. On the swinging bracket are mounted the synchronism indicator with lamps, the frequency indicator and one horizontal edgewise A. C. voltmeter for reading bus and transformer potential. The frequency indicator indicates bus frequency. All instruments on this panel as well as on the whole switchboard have a dull black finish.

The general scheme of connections is shown in the accompanying diagram. The generator switches are non-automatic, while the transformer high tension and low tension switches, and also the line switch and 6,600-volt auxiliary switch, are automatic. The low tension automatic switches have their relays mounted at the switchboard,

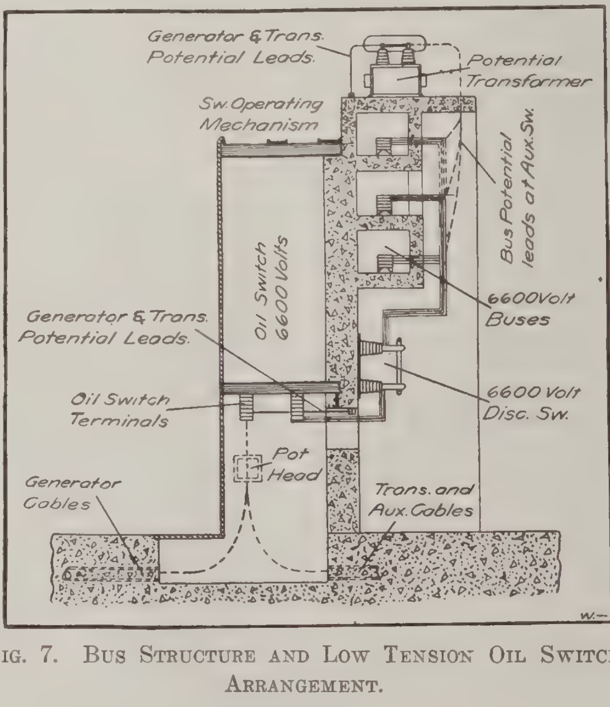


Fig. 7. Bus Structure and Low Tension Oil Switch Arrangement.

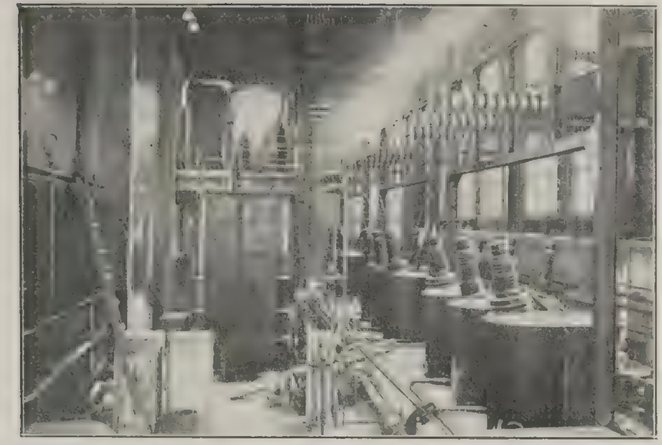


FIG. 8. SHOWING 120,000-VOLT OIL SWITCHES—LIGHTNING ARRESTER TANKS IN GALLERY AND TRANSFORMERS IN POSITION.

while the K-21 switches have the relays mounted at the switch and are controlled by bushing type current transformers that operate these relays only. The generator neutral oil switch has an interlocking device in the tripping circuit connected to a set of contacts on the generator switch, so that the neutral switch is opened automatically when the generator switch is opened. The control solenoid for the air-operated disconnecting switches also have the wire to the opening coil connected through an auxiliary contact on the corresponding K-21 oil switch, so that the disconnecting switches cannot be opened until the oil switch is opened. This prevents opening the disconnecting switch under load.

The cable for control and otherwise is run in the floor and laid in fibre ducts. The exceptions to this are the field leads, rheostat control and current transformer secondaries going from the switchboard to the gallery. All cable, except the ground wire for generators, etc., is lead-covered. From the generators, the main leads of single conductor 1,500,000 c. m. lead-covered cable insulated for 6,600 volts run to the generator H-3 oil switch through disconnecting switches to the bus. This cable is run in 4-inch fibre conduit. The neutral lead of 750,000 c. m. cable goes direct to the K-12 single pole oil switch on the river wall of the building. The current transformers for the generators are installed in the generator pit, the secondaries going through fibre conduit to the switchboard. From the bus compartment the transformer cable goes through disconnecting switches to the transformer H-3 oil switch out to the low tension side of the transformers. The current transformers for the transformer leads are installed on channel iron supports at the low tension side of the transformer. All potential transformers are installed on top of the concrete bus structure, their secondary leads going to the switchboard through fibre conduit. All cable, except current and potential transformer secondaries and control cable, is single conductor except a three conductor, 6,600 volt cable for the auxiliary transformer fed from the 6,600-volt bus through disconnecting switches and an H-3 oil switch. The current transformers for the auxiliary apparatus are in the 6,600-volt circuit near the auxiliary transformers. From the primary side of the main transformers the leads go through K-21 oil switches to air-break, solenoid-operated, 120,000-volt disconnecting switches to the bus. All high tension leads are of 15/16-inch outside diameter copper tubing. From the bus the leads go through a K-21 oil switch to the choke coils through the roof to the line disconnecting switch. The high tension bus and all high tension leads are supported on post type 8-disc insulator for 120,000 volts. The lightning arrester leads are tapped on the roof where the horn gaps are installed.

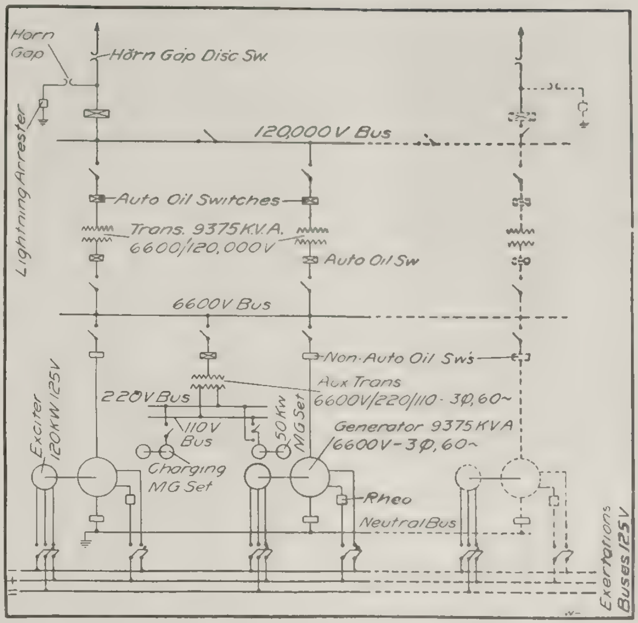


FIG. 9. GENERAL LAYOUT OF APPARATUS AT NO. 2 STATION.

TRANSMISSION LINE CONNECTING STATIONS NOS. 1 AND 2.

The permanent transmission line connecting stations Nos. 1 and 2 is a single tower, double circuit line, built on a 100-foot right of way. The line follows the north side of the lake from Parksville to a point about 2,000 feet below power house No. 2, where it crosses to the south side of the river. The span where the line crosses the Ocoee is 1,300 feet long and is about 400 feet above the river. The country passed through by this line is very mountainous, and the spans vary from 350 feet to 1,400 feet in length. The towers, as stated, are double circuit towers of standard Milliken make, designed with crossarm spacing for 120,000 volts—that is, 10 feet between crossarms and height to ground wire clamp at the top 75 feet 6 inches. Each tower is designed to stand a load of 1,500 pounds applied simultaneously at each insulator support—a load of 10,000 pounds applied at the middle crossarm either parallel to or at right angles to the line, and a load of 3,000 pounds applied simultaneously at both ends of any two crossarms, the load on the two ends of a crossarm to be in opposite directions, but parallel to the line. These towers are, in almost every case, set in concrete, and all strain towers and all angle towers are guyed on four corners by ⅝-inch galvanized steel guy wire anchored to a ⅝-inch steel rod 6 feet long, which passes through an 8-inch chestnut log 6 feet long, and is held by a 4-inch washer. The guy wire is held to the tower by a chain attached to the tower just above the junction with the first crossarm. Due to the hilly country, the material for the concrete tower footings had to be hauled by oxen up the side of the mountains and through most inaccessible trails. The excavation for the tower footings alone was about 1,650 cubic yards, while the concrete required for tower footings was 2,325 cubic yards.

The line itself consists of two 3-phase circuits of No. 2/0 copper wire, each phase being placed on one side of the tower with the three wires in a vertical plane. The insulators are 10-inch disc type of the Ohio Brass Company, hung 8 in series for strain towers and 7 in series for suspension. This line is insulated for 120,000 volts, although operating at 66,000 volts. There are two transposition towers between No. 1 and No. 2 power houses. The transpositions are made by having extensions placed on the top and bottom crossarms. The sag of the lines is figured for ½ inch of ice, 8 pounds of wind pressure, and a tension of 2,710 pounds in the 2/0 conductor at 30 degrees F. The ground wire is 5-16 inch standard steel wire, copper clad. This wire is clamped at the top of each tower, and thus is grounded at each tower. At Parksville one circuit enters the power house and forms the tie line between the two stations, while the other circuit continues on the towers to a point just beyond Parksville, where the proposed line for the Aluminum Company of America at Maryville will connect. This line is now under construction.

On September 11, 1913, water was turned into one section of the flume about a mile long. The water was kept in this section to allow the flume to swell and to close all leaks. The flume was caulked throughout and each section tested. After testing, any leaks that developed were marked and the water taken out of the flume so that the leaky sections could be recaulked. By this method of testing the leaky sections were discovered before the flume was placed in operation, thus avoiding the danger of slides on the mountain side due to leakages which could not have been stopped without shutting down the plant.

Water was turned into the penstock October 19, 1913, and one unit started. After this generator was dried out, the station was put in parallel with Parksville October 24 and carried a load. The second unit was placed into operation a few days later. This station is essentially a unity load factor and a unity power factor station. That is, the station will run at full load on the water wheels, and the generator capacity will be utilized at unity power factor so as to use the full stream flow up to the station capacity, so that no water will be wasted.

The entire work of construction and engineering was done by the J. G. White Engineering Corps of 43 Exchange Place, New York City, under the direction of Mr. J. G. Munson as construction superintendent.

Important Considerations When Ordering Power Transformers

BY H. G. DAVIS, E. E.

Section 5. Essential Conditions for Operating Transformers in Parallel.

When ordering any transformer, the problem of operating it in parallel with other transformers on the system should be considered. Unless it is used singly to supply some given network or some motor drive, the question of parallel operation is important. In any case the chances are that at some time the transformer will be used in parallel with some other transformer on the system. For successful operation in parallel on both primary and secondary sides, the first consideration is that the transformers must of necessity have the same voltage ratio and the leads must be connected together to leads of like polarity. This applies to single phase transformers and means that ratio and polarity must be exact. Before paralleling, the two transformers can be tested for polarity as given in another section under polarity test. By simply reversing the leads of one winding of one transformer the polarity of two single-phase transformers can be made correct for paralleling if the two are not of proper polarity of leads to begin with. For paralleling single phase transformers the voltages must be exact and the phase position alike.

If two transformers in parallel on the primary side have different voltages on the same secondary side, when paralleled on the secondary the difference in voltage will cause a current to circulate through the two secondaries. This current will be the current due to the difference of the two secondary voltages divided by the sum of the impedances of the two transformers. The effect of this exchange current is to balance the voltages of the two transformers with a resultant equilibrium of the two transformers. To determine this current assume that e_1 and z_1 are secondary voltage and impedance in secondary terms of one transformer and that e_2 and z_2 are corresponding terms of the second transformer. The exchange current would be $(e_1 - e_2) \div (z_1 + z_2)$ where z_1 and z_2 are expressed in ohms. The impedance z_1 can be found for the first transformer by impressing a voltage on the secondary with the primary short circuited. Read the current. If I is current and E is voltage then $z_1 = (E/I)$. This same could be determined for the other transformer. This is the condition which results at no load on the transformer and shows the importance of exact ratio. With a difference in secondary voltage as load is put on two transformers in parallel the one having the higher voltage will take the load until its voltage drops to the value of that of the other transformer. The second transformer will then begin to take load. Thus unless the two transformers have voltages of the same value there will be an exchange current at no load and one transformer will take a large load before the other begins to take load at all.

With transformers having identical ratio values, when operating in parallel the load taken from each transformer will be such that the terminal voltages are equal. Thus for any number of thansformers in parallel and having current values, i_1; i_2; i_3 etc., and impedance in ohms = z_1; z_2; z_3 etc. the drops are $i_1 z_1$; $i_2 z_2$; $i_3 z_3$ etc. Since the ratios are equal and thus no load voltages are equal, the drops in voltages for the different transformers will be equal if operating in parallel.

$$\text{Thus, } i_1 z_1 = i_2 z_2 = i_3 z_3 \text{ etc.}$$

$$\text{and } i_1/i_2 = z_2/z_1 \text{ and } i_1/i_3 = z_3/z_1$$

This means that the load carried by each transformer will vary inversely as the impedance. For each transformer to carry full load, its current multiplied by its impedance must be equal to the product of the same quantities in each of the other transformers. Thus the impedance volts at full load for all transformers operating in parallel must be equal if each transformer is to carry its proportion of the total load.

Assume a 10 Kva. transformer and a 5 Kva. transformer to be operated in parallel. Assume each transformer to be 2300 to 220 volts. If the impedance volts on the 10 Kva. transformer measured on the 220 volt winding with the primary short circuited and forcing full load current through the secondary is 4 per cent or .04 x 220 = 8.8 volts. Then, for proportional division of load the impedance volts on the secondary of the 5 Kva. transformer should be 8.8 volts.

Thus for the 10 Kva. machine 8.8 volts = $z_1 \times$ secondary current = $z_1 \times 45.5$. Then $z_1 = .193$.

For the 5 Kva: 8.8 volts = $z_2 \times$ secondary current = $z_2 \times 22.75$. $z_2 = .386$ ohms impedance.

The load carried is inversely proportioned to the impedance. Suppose that the 5 Kva. transformer had impedance volts with full load current of only 6 volts. Then $6 = z_2 \times 22.75$ and $z_2 = .264$.

Under this condition the load on the 10 Kva machine bears the same relation to the load on the 5 Kva. machine as the impedance of the 5 Kva. machine bears to the impendance of the 10 Kva. machine.

Thus (Load on 10 Kva.) ÷ (Load on 5 Kva.) = .264 ÷ .193 = 1.37.

Instead of carrying twice the load as it should according to the rating, the 10 Kva. transformer carries only 1.37 × the load on the 5 Kva. For a total load on the combination of 15 Kva., the 5 Kva. transformer load can be represented by 1 and the load on the 10 Kva. machine by 1.37. The total load can be represented by 2.37. The load on the 5 Kva. machine is (15/2.37) = 6.32 Kva. and the load on the 10 Kva. machine is 6.32 × 1.37 = 8.68. Thus the 5 Kva. machine has an over load of 26 per cent, while the 10 Kva. machine is loaded to only 86.8 per cent of its rating. These same considerations apply to any number of transformers in parallel and apply to single-phase and poly-phase when considering division of load according to impedance.

From the above we see that for paralleling transformers the polarity should be the same, the ratios should be identical and the impedances should be inversely proportional to the rating. This shows the value of knowing the ratios and impedances of all transformers in a bank. Otherwise, a small transformer with low impedance might be placed in a bank with larger transformers and while the load taken from the network might be less than the combined ratings, one transformer with lower impedance might take enough load to be destroyed although having the same identical ratios as those with which it is operating. Thus a record should be kept of ratios for all transformers to operate in parallel on both primary and secondary with transformers already installed. The impedance values of those installed should be known and the specifications should call for parallel operation with the installed transformers.

Polyphase transformers, in addition to phase position and exact ratio require that the phase rotation be alike for any two banks of transformers. There are combination of three-phase transformers that will not work although their voltages are exactly alike. For parallel operation on both primary and secondary sides the following table shows the combinations that will work. Assuming two 3-phase transformers or two banks of three single-phase transformers, the possible combinations on low tension and high tension sides are shown for parallel operation. The two banks are called A and B.

OPERATIVE PARALLEL CONNECTIONS.

	Low Tension Side		High Tension Side	
	A	B	A	B
1	Delta	Delta	Delta	Delta
2	Star	Star	Star	Star
3	Delta	Star	Delta	Star
4	Star	Delta	Star	Delta
5	Delta	Delta	Star	Star
6	Delta	Star	Star	Delta
7	Star	Star	Delta	Delta
8	Star	Delta	Delta	Star

There are four other combinations possible for these two banks of transformers, but these combinations will not operate in parallel. These are as follows:

INOPERATIVE PARALLEL CONNECTIONS.

	Low Tension Side		High Tension Side	
	A	B	A	B
1	Delta	Delta	Delta	Star
2	Delta	Delta	Star	Delta
3	Star	Star	Delta	Star
4	Star	Star	Star	Delta

The above polyphase connections as given are for three-phase transformers or for two banks of 3 single-phase transformers connected similarly, that is having their delta or star connections formed in exactly the same way for each bank. If the single-phase transformers forming one bank are of different polarity from those forming the other combination it will be impossible to parallel the two combinations, even if the combination is an operative one as given in the table, unless one bank has one phase of each transformer reversed. This will make the polarity of the individual transformers of the two banks correspond and bring the phase position of the two banks together so that parallel operation will result. Thus it is necessary to know the polarity of all single phase transformers and also the high tension and low tension connections for all polyphase transformers so that operative connections can be made when installing other transformers in parallel. In general for all transformers installed the following characteristics should be known or tabulated for reference: Voltages primary and secondary—polarity—direct or opposite wound—if polyphase, method of connection of primary and secondary and—impedance per phase in ohms.

REGULATION.

The regulation of each transformer should be known and tabulated for reference and the regulation should be obtained in all guarantees for a transformer for which an order is placed. To determine regulation the impedance and resistance of a transformer must be known and thus we see that the regulation of a transformer is directly connected with the question of load division of transformers operating in multiple. By regulation is meant the change in secondary voltage between no load and full load. If we have a transformer operating fully loaded and with a constant impressed primary voltage, a decrease in load taken from the transformer will allow the secondary voltage to rise provided the primary voltage is held constant. The rise in secondary voltage above the voltage at full load expressed in per cent of full load secondary voltage is the regulation. This is regulation as expressed by the rules of the American Institute of Electrical Engineers. Another way of looking at regulation is this: Consider a transformer at no load which has a certain secondary voltage corresponding to a constant primary voltage. As the load is increased on this transformer for a constant impressed primary voltage the secondary voltage will decrease, due to the resistance and reactance of the transformer. Now a decrease of voltage as load increases is objectionable since it comes when the wires feeding from the transformers are loaded and more voltage is required from the transformer. Thus in order to hold the secondary voltage constant when load comes on it is necessary to increase the primary voltage. This increase in primary voltage to compensate for the drop in the transformer secondary is sometimes called regulation. In any case it is the variation of voltage caused by the load on the transformer and low regulation means that the voltage variation is low. This is naturally what is desired most as a low regulation means very slight increase in voltage required to compensate.

There are many formulas given for regulation. These are:

Per cent regulation $= \mathrm{I\ R\ Cos}\ \phi + \mathrm{I\ X\ sin}\ \phi + [(\mathrm{I\ X\ Cos}\ \phi - \mathrm{I\ R\ sin}\ \phi)^2]/200$ ....(1)

Neglecting the last term in the equation,

Per cent regulation $= \mathrm{I\ R\ Cos}\ \phi + \mathrm{I\ X\ sin}\ \phi$.....(2)

Other equations are,

Per cent regulation at any P. F. $= 100 \sqrt{\ } (1 + \mathrm{C}^2 + \mathrm{d}^2 + 2\mathrm{c\ Cos}\ \phi + 2\ \mathrm{d\ sin}\ \phi)$.......................(3)

For 100 per cent P. F. per cent regulation $= \mathrm{I\ R} + [(\mathrm{I\ X})^2 + 2\ \mathrm{I\ X}\ m]/200$..........................(4)

If we neglect m in (4),

Per cent regulation $= \mathrm{I\ R} + (I\ X)^2/200$ or per cent regulation $=$ I R considering the last term negligible.

The symbols used in the above equations are: I = current; R = total transformer resistance; X = total transformer reactance; I R = total resistance drop expressed in per cent of rated voltage; IX = reactive drop expressed in per cent of rated voltage; Cos ϕ = power factor of load; ϕ = angle of lag of secondary current behind secondary; voltage for the power factor as given above; m = per cent magnetizing current; $C = \mathrm{I\ R}/100$; and $d = \mathrm{I\ X}/100$.

These equations show that regulation is a function of the resistance and reactance of the transformer. The division of load between two transformers is dependent on these two quantities so that for proportional division of load two transformers must have the same impedance drop for their rated loads or the regulations of each transformer should be identical or very close at their rated load. This can be seen when we consider that regulation means voltage drop and transformers in parallel have the same terminal voltages. Thus the transformer with low regulation would require a larger proportion of load to reduce its voltage than would be required by a transformer of high regulation. Hence it might be said that transformer regulation like impedance determines the proportional load division.

From the formulas as given we can see that the qualities that determine regulation are resistance and reactance. To have low resistance we must have large cross section of copper and for low reactance we would require a great increase in iron loss or in material necessary. This would, of course, mean a more expensive transformer. Thus it would be out of the question to obtain a transformer with the best regulation unless some other characteristic is sacrificed. All the characteristics should be considered and given their full value.

When regulation is considered, the value will increase when the number of hours per day of full load operation on the transformer increases. Thus the value of regulation can be figured against core loss and a decision made as to which is more important. The importance of lighting to the consumer should be given its full value. Every station, however, has its local conditions to meet.

The considerations entered into should be as to whether or not regulation is of more value than iron loss. This is determined by operating conditions. Again existing or installed transformers should be considered if parallel operation is desired. However, the regulation of transformers should be known and those of approximately the same regulation should be paralleled. This is most desirable if feeder regulators are used to compensate for line drop to a group of transformers in multiple.

Testing Polyphase Station Watthour Meters

BY HENRY A. COZZENS, JR.

Much has been written on the subject of testing consumers' meters but little stress has been laid on the periodic testing of station watthour meters. In all probability this is due to the fact that the station meter has no direct bearing on the money income of the company, its function being merely to record somewhat approximately the station load for statistical data. Nevertheless these meters should be tested periodically for two reasons. First, continued reliability and second, economical maintenance. Of these the first is dependent on the second, for if the meter be kept in good operating condition, reliability and accuracy can but logically result. Of course it must be admitted that the station meter located on a well maintained switchboard is not as a rule subject to the dirt, vibration and detrimental conditions to be found in sonsumers' installations, but regardless of this a periodic test should be made to insure accuracy.

With the utility with which the writer is connected, it is the practice to install a polyphase watthour meter on all generator circuits in stations and on all transformer circuits in substations, and in many cases on the station end of feeders supplying large consumers. In the private laboratory maintained by this company, one branch calibrates the standards and instruments used by the various meter departments and also is responsible for the routine testing of the station meters located on both alternating and continuous current circuits. The methods and system used in the testing of meters have resulted from a study of the conditions affecting each of the various stations. All induction meters are tested regularly every six months unless local troubles call for more frequent tests. Particular attention is directed toward the removal of the condition which causes the meter to be inaccurate as opposed to the method of time after time adjusting the meter. By applying a little well spent time in taking down a meter and thoroughly cleaning and inspecting it, not only is the life lengthened but confidence may be placed in the proper performance of the meter.

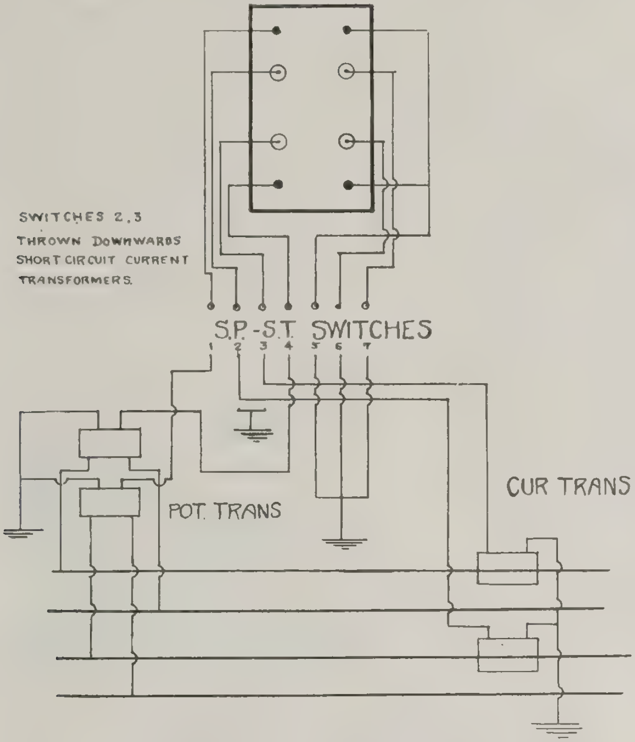

SWITCHES 2,3 THROWN DOWNWARDS SHORT CIRCUIT CURRENT TRANSFORMERS.
S.P.-S.T. SWITCHES
1 2 3 4 5 6 7
POT. TRANS
CUR TRANS

Fig. 1. Arrangement of Connections for Testing 4-Wire Watthour Meter.

In testing some meters an indicating wattmeter and a stop watch are used, but in general, in order to expedite the testing, a rotating standard of the laboratory type is employed. This standard is checked frequently in the laboratory so that the calibration of station meters may be regarded as being more refined than that of the meters located on consumers' premises. Most of the meters are five ampere secondary meters and are tested with a light load of one quarter ampere and a full load of four and three-quarters amperes or over. If the meter is found to be between 99 and 101 per cent accuracy, no adjustment is made, but when an adjustment is required, the meter must be left with an accuracy between 99.5 and 100.5 per cent.

To facilitate the testing of alternating current watthour meters, switches have been installed on most of the meter panels. To date, this has not been uniform as for instance in one division the regular meter testing switch which short circuits the transformers when in its open position is made use of, while in the older plants small single-pole, single-throw knife switches have been mounted on a bracket in the rear of the meter panels. These switches and their connections to a two-phase, four wire watthour meter are shown in Fig. 1. The two switches placed between the current coils of the meter and the series transformers are double throw switches having one side connected to the coils while the other side connects to ground, thereby short circuiting the transformers during the testing of the meters. This is done not only to protect the ratio of the transformer but also the men who are working on the meters.

The method of wiring the meter for test is shown in Fig. 2. To attach the wires to the switches, regular rubber covered test clips are used, and in order to reduce the number of wires to a minimum, the two wires to the current coils and the two wires to the potential coils are bound together in the form of a cable which may be thrown over the top of the panel. The operator stands in front of the meter with the standard and load box at his side. He first secures the proper load on a regular meter testing rheostat, preferably starting with full load. He reads the standard and starts both the meter under test and the standard by closing the snap switch. After counting the requisite number of revolutions, which practice has determined to be ten for full load and one for light load, he stops the meters and reads the standard once more. The difference of the two readings when corrected and multiplied by the transformer ratios gives the watt seconds from which the accuracy may be computed.

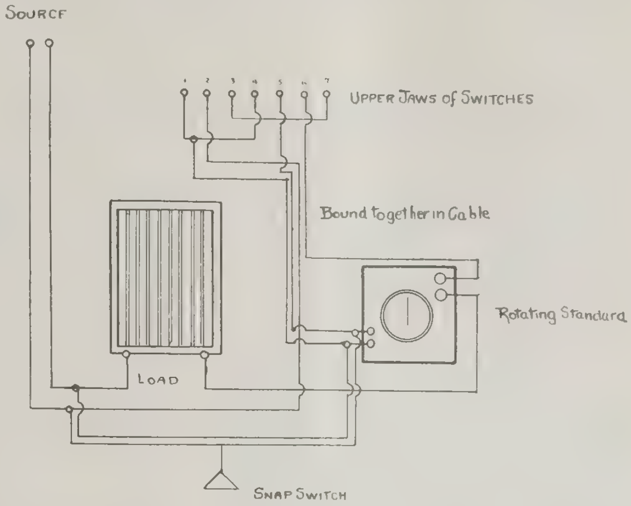


Fig. 2. Connections for Testing a Single-Phase Meter.

J. G. White and Friends Visit Properties of Southern Utilities Company.

Mr. J. G. White, of the J. G. White Companies, 43 Exchange Place, New York City, accompanied by a party of some sixty friends and business associates, recently made a trip through Florida, visiting many of the towns where there are electric light, power and ice plants owned by the Southern Utilities Company. The itinerary covered the main railroad line as far as Jacksonville, where the party will branch off to visit the towns of Kissimmee, Lakeland, Punta Gorda, Fort Meyers, Bradentown, St. Petersburg, Belleair and Tarpon Springs, on the west coast.

At Tarpon Springs it had been arranged so that the party might see a demonstration by sponge divers. These men, who are all Greeks, are wonderfully adept at descending to great depth and remaining there for a long time. It is only recently that they have availed themselves of helmets and other diving paraphernalia. A side trip lasting two days was taken from Fort Meyers up the Caloosahatchee River, which is the waterway connecting Lake Okeechobee with the Gulf of Mexico, and, together with a ship canal from Lake Okeechobee to the Atlantic, cuts through the whole width of Florida. The recent decision of the government, which determined that the Everglades can be drained, made this portion of the trip especially interesting. Leaving the west coast, the party stopped a day to visit the celery and vegetable fields near Sanford and to see the ice and electric plants of the Southern Utilities Company. Two full days were spent at Fellsmere inspecting the drainage operations and agricultural developments there.

Some Important Characteristics of Small High Tension Substations

BY H. W. YOUNG, ASSOC. A. I. E. E.

A Discussion of Important Features Essential to Economical Distribution of High Tension Power.

PRIOR to the building of transmission networks and high tension distribution feeders radiating from a central point to small communities, the cost of lines to reach the small consumer, combined with the high cost per kilowatt of switching and protective apparatus, practically closed a field which is now open to successful and profitable development. The problem of the transmission company in the South today resolves itself into the building of lines from a station or stations of considerable capacity to a definite point where a load of suitable characteristics to justify the expense in securing same can be connected. The question of taking on the small consumer near these lines is one involving engineering features necessary to provide service at the smallest initial investment and maintenance cost. Here the development of the outdoor substation has been imperative and a subject on which considerable engineering thought has and is now being devoted.

In general the requirements of outdoor substations are that the transformers be absolutely weatherproof, preventing entrance of moisture and that the switching and protective gear be simple in design, effective, easily installed and have a low maintenance cost. The general tendency today in the design of such stations seems to point toward the use of an air-break switch capable of opening loaded circuits, a suitable fuse, discharging horn gaps, and a choke coil or inductance so located as to reflect excess potentials to the gaps where they can be discharged. In what follows certain considerations essential to successful operation of small and average sized high tension substations are discussed by H. W. Young, an engineer and designer of such equipment, the material being abstracted from a paper presented by him before a joint meeting of the electrical section of the Western Society of Engineers and the Chicago Section of A. I. E. E., at Chicago during the latter part of December of last year.

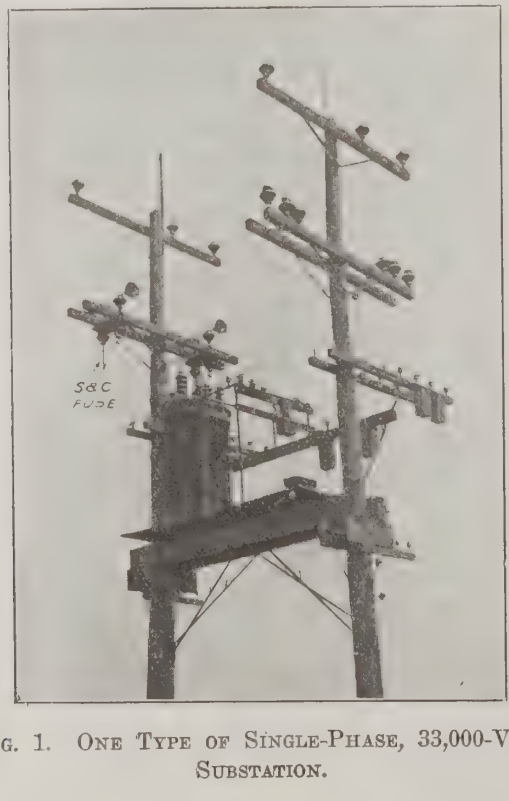


FIG. 1. ONE TYPE OF SINGLE-PHASE, 33,000-VOLT SUBSTATION.

TYPES OF SUB-STATIONS.

During the past two years several distinct types of outdoor sub-stations have been developed and a large number are now in service. Some of the earlier small capacity types are shown in Figs. 1 and 2, and are of very simple construction. The transformers are of the single phase weatherproof form mounted on a suitable platform supported by two standard poles; the lightning protective equipment consists of a pair of adjustable horn gaps set to "spill over" at approximately a predetermined value. Protection against overloads is secured by the use of special high tension fuses mounted either above or below the crossarms as desired, and when renewal becomes necessary a fuse can be removed and replaced by means of insulated tongs. The control switches are located on the next pole; in some cases these consist of a simple disconnecting type and in others, a switch designed to open loaded circuits is used. An interesting feature of these stations is that the automatic street lighting regulators are also of the weatherproof type and are mounted near the main transformer.

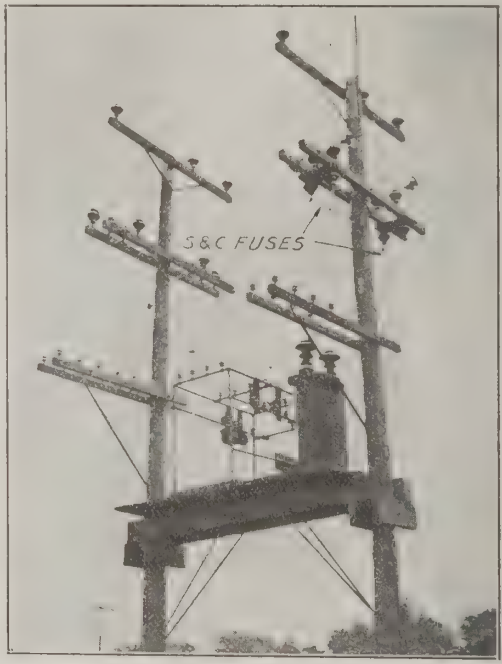


FIG. 2. ANOTHER ARRANGEMENT FOR SINGLE PHASE SUBSTATION.

The first stations erected were usually single phase for supplying street or commercial lighting, but the necessity for power service soon developed and the type shown in Fig. 3 was designed. This station is of 100 kw. capacity transforming from 22,000 to 2,300 volts; the secondary distribution is carried out in the usual manner, 2200/110/220 volt transformers being located near the consumer's premises. In the particular installation shown, the control switches are of the simple disconnecting type, but when conditions are such that opening the high tension circuit under load is necessary, the type of switch shown in Figs. 4 and 5 is extensively used. Where the main transmission lines are adequately protected with lightning arresters located near the point where power is taken off, the installation shown in Fig. 6 can be used to good advantage. This installation is simply protected by means of weatherproof high tension fuses mounted directly above the transformers, the disconnecting switches being on the next pole.

A second type of outdoor sub-station installation, where the entire transformers, switching, and protective equipment are mounted on the same structure, is shown in Figs. 7 and 8. The transformer is of the three-phase type transforming from 33,000 volts to 2,200, the secondary distribution being of the usual type employing 2200/110/220 volt transformers. It will be noted that the three-pole switch handle is located below the platform. The air break switch is opened before the linemen mount the platform, which increases the safety factor. Protection against overloads and lightning is secured by the use of high tension fuses, choke coils, and discharging horns. A small house is provided for secondary switches, meters, spare parts, etc.

A third type of three-phase station is shown in Fig. 9 and is rather interesting in that it is designed to supply current for an entire town. This particular installation is of 300 kw. capacity and is located outside an old steam plant which can be shut down at will; the sub-station can take current from the main lines, or the steam plant can be operated as an auxiliary feeding into the main line if it becomes necessary. The 2,200 volt circuits are carried into the building at the left and distribution is made in the

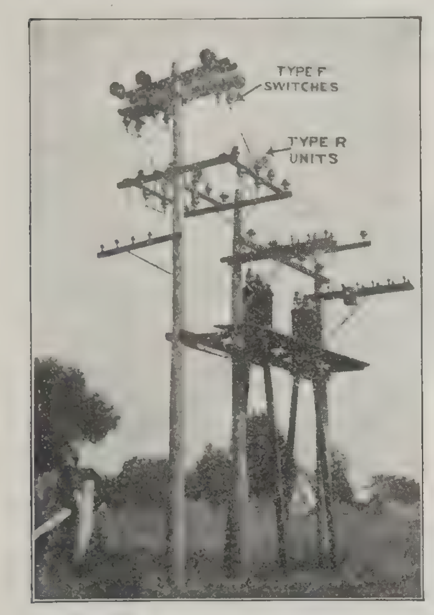


FIG. 3. A THREE-PHASE, 22,000-VOLT SUBSTATION.

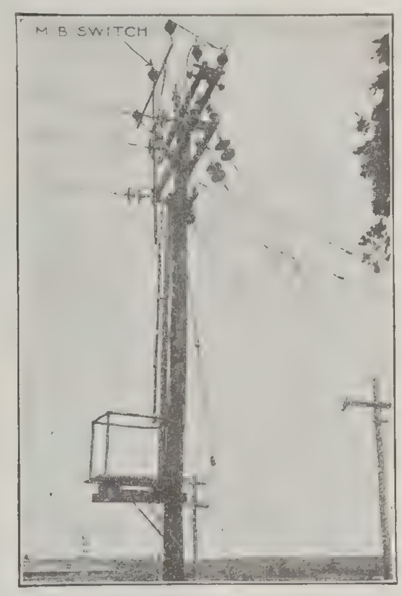


FIG. 4. A 22,000-VOLT POLE TOP SWITCH INSTALLATION ON SYSTEM OF GEORGIA RAILWAY & POWER CO.

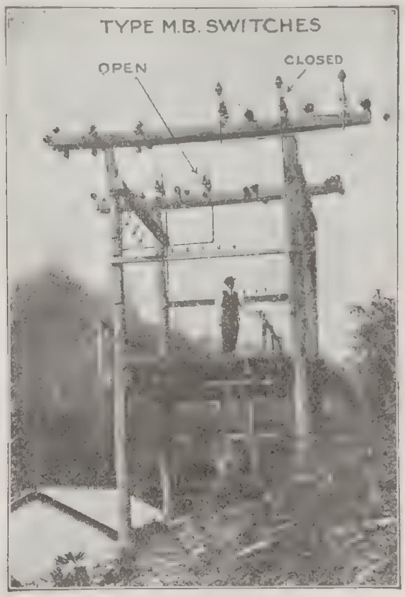


FIG. 5. AN INSTALLATION OF TWO 22,000-VOLT POLE TOP SWITCHES.

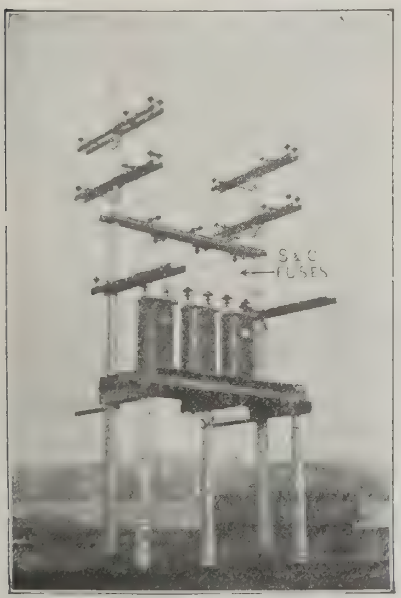


FIG. 6. A 33,000-VOLT STATION WITH FUSE PROTECTION ONLY.

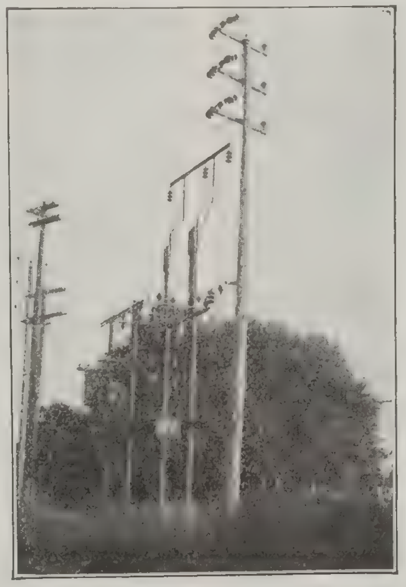


FIG. 7. A COMPLETE STATION FOR HIGH TENSION LOAD SWITCHING.

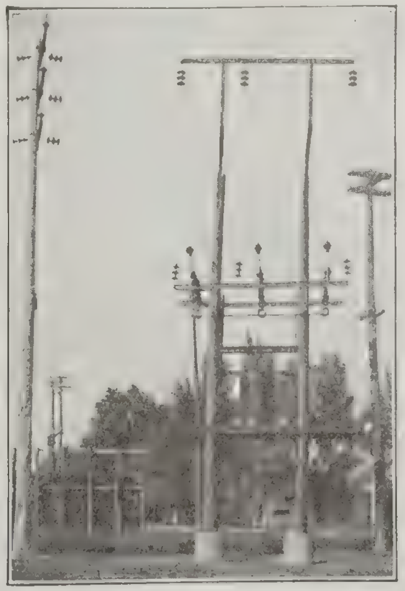


FIG. 8. A THREE-PHASE TRANSFORMER 33,000-VOLT SUBSTATION.

usual manner. With this arrangement the town can be supplied with current from the high tension 33,000 volt line, the local generating plant being shut down; or the local plant can, when desired, be used as a generating point, feeding into the main line through the outdoor sub-station.

A fourth type of high tension sub-station is shown in Fig. 10, and as will be noted the three phase air break switch is mounted on a separate pole adjacent to the three poles supporting the transformers, lightning arrester, and fuse equipment. This particular installation is connected to a 33,000 volt transmission system supplying power to a coal mine. Several of these stations are now in commercial operation and their operation under heavy sleet conditions will be watched with much interest. The switching equipment is so designed that it can be operated under severe sleet conditions, as in the particular territory where these stations are installed, sleet storms of great severity are quite common. The type of station shown in Fig. 11 employs the same form of switch as the preceding station. It will be noted that the fuse, lightning arrester, and transformer equipment are all concentrated at one point, thus giving a self-contained installation. An interesting steel tower sub-station is shown in Fig. 12, a number of installations being in commercial service. It will be noted that the transformers and protective equipment are mounted on a common structure and the switch on a separate pole.

CONTINUITY OF SERVICE.

Anticipating the question as to the possibility of securing uninterrupted service, it can be said that absolute continuity of service cannot be guaranteed with any present type of outdoor sub-station equipment, nor is it expected, with the low-cost types commercially available. With the latter types, in case of a heavy flow of current to ground, the protective fuse will perform its functions and rupture, thus cutting off the service. This condition must be admitted, but in a large percentage of cases an occasional interruption of outdoor sub-station service will not be considered serious or as a criticism of the service. It is obviously preferable to use this lower-cost switching and protective equipment, giving service which, while subject to an occasional interruption, insures a profit on the investment, than it is to use a higher-cost, more elaborate equipment, which, while it may insure fewer interruptions, will invariably render the venture unprofitable.

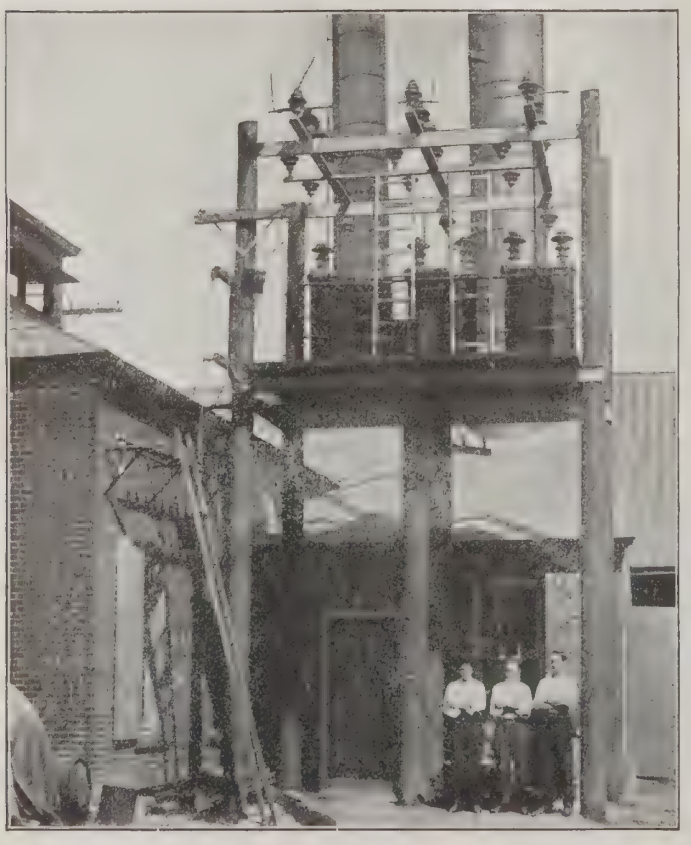


FIG. 9. A 300-KW. 33,000-VOLT SUBSTATION OUTSIDE AN OLD GENERATING STATION.

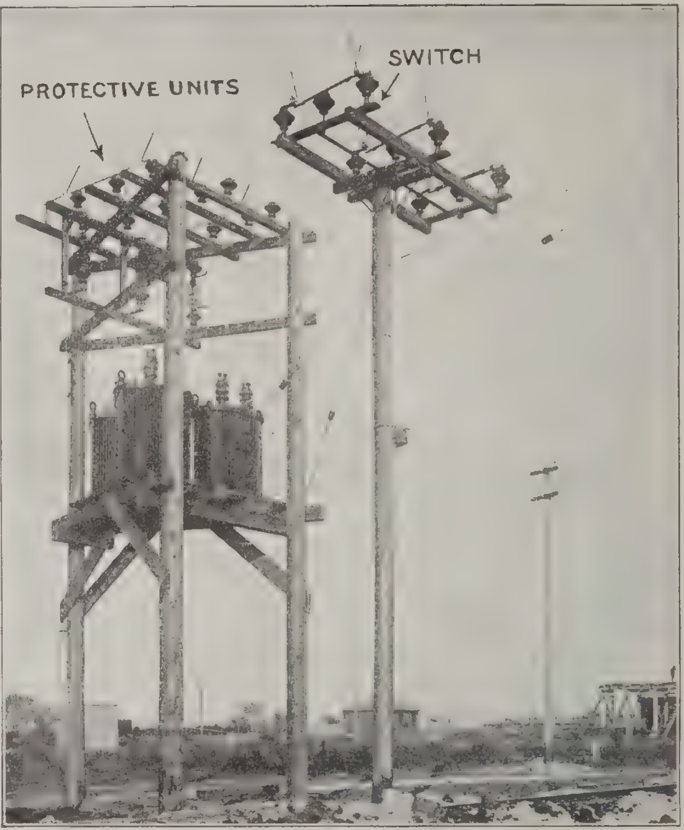


FIG. 10. A 33,000-VOLT SUBSTATION WITH SWITCH ON SEPARATE POLE.

Probably the most frequent cause of interruption on high tension systems is due to the failure of insulation; in other words, the line insulators used are frequently too light to meet those abnormal conditions which occasionally arise. The use of liberally designed insulators on the lines, the installation of electrolytic arresters at generating stations or important distribution points, and the frequent installation of air break sectionizing switches, will materially aid in decreasing interruption to main lines or feeders. The outdoor sub-station equipment branching from these lines will take care of itself so far as interruption to service is concerned, as any disturbance or trouble will be localized by the fuses and prevented from spreading to the main feeder lines—something of the highest importance.

OVERLOAD PROTECTION.

While automatic oil switches have been designed for outdoor service, it is questionable if they are suitable for use in connection with small sub-stations, as it is quite necessary to frequently inspect the contacts, height, and condition of oil, make adjustments, etc. A comparatively small amount of water will result in serious trouble, and inspection must be made in fair weather or with the switch under cover. Again the oil switch cannot be thoroughly inspected without killing the line, and when means are provided for by-passing the switch to cut it out of service, the necessary extra equipment becomes cumbersome and expensive.

The outdoor types of non-automatic air break switches with fuses have met the requirements of commercial service and are certainly far safer to install, inspect, and operate than are oil switches. Attempts have been made to employ the standard types of high tension indoor oil switches for outdoor service by providing housings, but this practically doubles the expense and still has the disadvantage of permitting no immediate and easy inspection when alive.

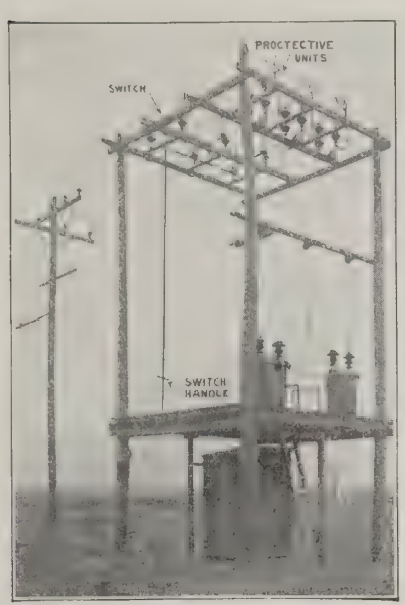


FIG. 11. A 33,000-VOLT SELF-CONTAINED TYPE OF SUB-STATION.

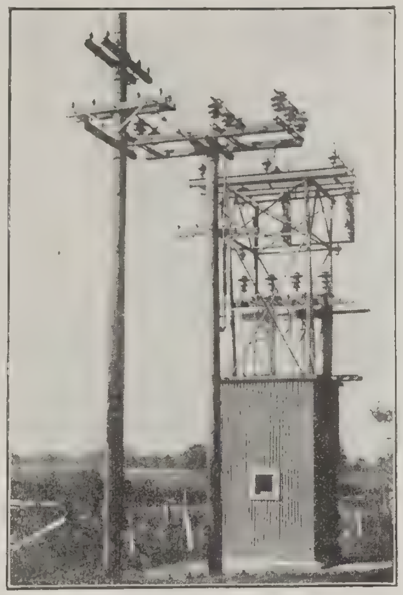


FIG. 12. A 33,000-VOLT STEEL TOWER OUTDOOR SUBSTATION.

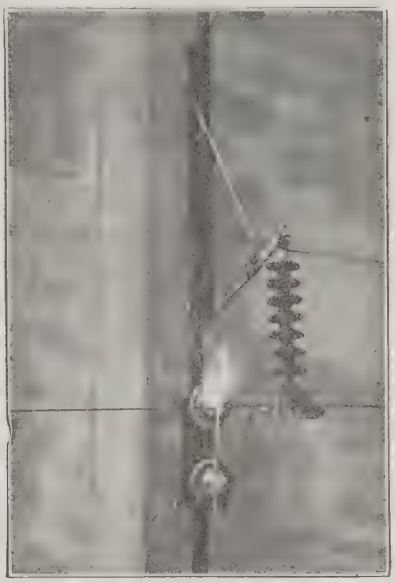


FIG. 14. SHOWING 66,000-VOLT FUSE BLOWING.

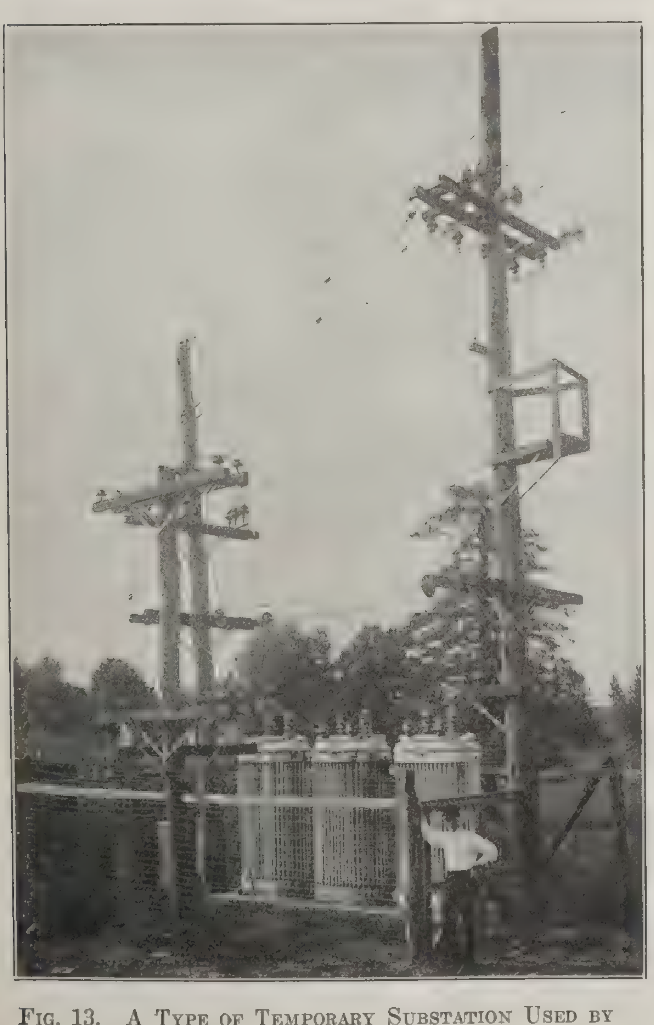


FIG. 13. A TYPE OF TEMPORARY SUBSTATION USED BY GEORGIA RAILWAY AND POWER COMPANY.

ADEQUATE FUSE PROTECTION.

The selection of a proper fuse to give adequate protection has been a vexing question, as the fuse must be of such design that it will not open under normal conditions, but will take care of those emergencies and abnormal conditions frequently arising in high tension distribution. One of the most successful types developed is the chemical form, consisting of a short fuse wire under tension and hermetically sealed in a glass tube filled with a carbon-tetrachloride solution. This form of fuse has the desired characteristics of quick action, minimum disturbance to the system, positive indication whether open or closed, and ready replacement. Aside from exhaustive laboratory tests, this fuse has been in successful commercial operation a sufficient length of time to thoroughly demonstrate its characteristics. Many short circuits have occurred on high capacity systems, and in every instance the fuse has cleared the lines without danger to either the feeders or generating installations.

An interesting illustration of fuse operation is shown in Fig. 13. This fuse, rated at 5 amp. 66,000 volts, was connected between one phase and the neutral point of a 110,000 volt bus fed by two 9,000 kv.-a generators operating in parallel. It will be seen that with the connections used, the fuses were subjected to approximately 66,000 volts, whereas on the regular 66,000 volt circuits, two fuses would always be in series in case of short circuit between phases. Should a short circuit occur between one phase and ground, the voltage across any fuse would approximate 38,000 volts, which is the usual method of operation. The successful performance under the conditions cited is conclusive evidence that the high tension fuses employed with the outdoor sub-stations illustrated are practical.

Atlanta Convention of the Tri-State Water and Light Convention.

The 1914 annual convention of the Tri-State Water and Light Association will be held at Atlanta, Ga., April 16 and 17. This association represents the interests of engineers and superintendents of city water works and electric light plants in the states of North and South Carolina and Georgia. A. J. Sproles, of Greenville, S. C., is president and F. C. Wyse, of Columbia, S. C., assistant secretary.

The Design, Installation and Operation of Series Lighting Systems

BY JAMES M. PURCELL.

With the progress in civic improvement and recognition of the fact that proper illumination of streets is a good measure of the progressiveness of a community, a decided interest has of late been shown by small towns throughout the South and West, in a better standard of lighting. This is manifested not only in the improvement of lighting in general, but also in the installation of ornamental, or "white way" lighting on the principal street of the town. The complex and varied methods of lighting in the larger cities are prohibited in the smaller towns by reason of their high initial cost and maintenance, so that a system to be practical for this class of work, must be simple, inexpensive and low in maintenance cost. The system which meets these requirements most satisfactorily in the writer's opinion is the series incandescent system.

Before going into a detailed discussion of this system, a general review of the street lighting situation will be presented. Two systems of distribution have been recognized, the multiple and the series. With the multiple system, current is taken from low voltage multiple lines. The standard 110 volts is too high for the arc lamp and a resistance must be cut in series with two lamps operated together. This system is in most cases obsolete for street lighting and need not be further considered. It is used for tungsten cluster lighting or curb lighting on ornamental posts, although it many cases this is also being superseded by the series system, so that the series system is now in general use for street lighting. In this system the same current passes through all of the lamps on a circuit; the current being kept constant and voltage varied as the number of lamps on the circuit is increased or decreased. In regard to the apparatus, or the lamps for converting the electricity into light, there are quite a number of different types in use, the essential characteristics being given in Table 1. The series tungsten incandescent unit which can now be obtained in sizes from 30 up to 350 candle power is the most important lamp now used in street lighting, for recent advances in the manufacture of the tungsten lamp indicate the probability of obtaining satisfactory incandescents having an efficiency of 0.5 watts per candle power making such a close competitor of arc lamps.

It is important to note that with the advent of the high efficiency series tungsten lamp, the street lighting situation was radically changed. Many small towns that could not see their way clear to install the arc system, with its large units and high maintenance cost, quickly adopted the incandescent lamp. This has allowed the use of small units placed more advantageously than the arc lamps and given a better average illumination. In addition, both the tungsten and the arc can be used successfully on the same circuit, making a system of great flexibility. In the outlying districts, with residences at great distances apart and where only a low intensity of illumination was necessary, a tungsten of low candle power could be installed, while in special locations where a more powerful light was required, an enclosed or flaming arc could be cut in the circuit. With the increase in the size of the tungsten lamps as now manufactured, in sizes comparable with the arc, this course will not be necessary and all tungsten units can be used. The series system is also adapted for use with ornamental pole lighting with a less installation cost than for a multiple system.

EQUIPMENT FOR SERIES SYSTEM.

To regulate and maintain a constant current in the series system which is necessary, special apparatus known as constant current or tub transformers must be installed. This transformer consists of a special form of laminated core of low magnetic reluctance, a stationary and a movable coil, the regulation depening upon the magnetic repulsion between moving and stationary coils. This method of regulation, because of its low power factor at low loads, constitutes one of the disadvantages of the "tub transformer." The efficiency at full load for a 100 light transformer is about 96 per cent, with a power factor of about 80 per cent. It decreases, however almost directly as the load decreases. For a system consisting entirely of incandescents, transformers built especially for this service can be obtained in sizes from 4 up to 35 Kw. The primary voltage may either be 1100 volts or 2200 volts, and with a secondary ampere rating of 2 amps up to 7.5 amperes. With the chance of having to install some arcs on the circuit, at some future time, a secondary rating of 6.6 or 7.5 amps would be desirable. This would require the use of in-

CHARACTERISTICS OF VARIOUS ARC* AND INCANDESCENT LAMPS.

Type of Lamp	Voltage Across Lamp	Current	Terminal Watts	Max. Candle-power.	Angle with Vertica for Max. C. P.	Mean lower H. S. Candle-power	Watts per H. S. C. P.	Kind of Glassware.		Life electrodes	
								Inner.	Outer.	Positive	Negative
Enclosed Arc. D. C.	72	6.6	475	525	65°	468	1.01	Opal—	Clear	125—	125
“ “ A. C.	72	7.5	480	350	40°	298	1.61	Opal—	Clear	100	
“ “ A. C.	72	6.6	425	275	40°	244	1.71	Opal—	Clear	110	
Magnetite Arc, D. C.	80	6.6	528	1600	80°	1170	.45	None—	Clear	1500—	100
“ “ D. C.	80	4.0	320	730	80°	457	.70	None—	Clear	4000—	175
Flame Arc. Long Burning D. C.	70	5.5	385	2575	70°	1800	.26	Clear—	Opal	70—	100
“ “ “ “ A. C.	70	5.5	350	1925	85°	1485	.24	Clear—	Clear	700—	100
Tungsten 1—Hor. C. P. 26	4.7	6.6	31								
“ “ “ 33	6.1	6.6	40								
“ “ “ 41	7.6	6.6	50								
“ “ “ 62	11.3	6.6	75								
“ “ “ 83	15.2	6.6	100								
“ “ “ 33	5.3	7.5	40								
“ “ “ 41	6.7	7.5	50								
“ “ “ 62	10.0	7.5	75								
“ “ “ 83	13.3	7.5	100								

*Arc characteristics from experiments at Illinois Eng. Experiment Station.

candescent lamps with large thick filaments, of a more rugged construction.

There are many advantages attached to the use of the constant current transformer which make it successful for the incandescent system. The regulation is close, which tends towards the maintenance of long lamp life. It also insulates the generating equipment at the plant from the outside circuit. By means of series transformers or safety coils, which can be cut in on the main circuit, a separate circuit can be run, at a lower potential and with the same or different values of the original current of the circuit. This allows the use of the series system which is of a high potential (and objectionable accordingly) in such places as underground distribution, ornamental post lighting, and even to the installation of a few lights in isolated buildings. A new type of underground cable, which has a spiral steel covering and can be laid in an open ditch and covered without further protection, has reduced the cost of such underground construction to a minimum, and has led to a great extension of the underground system for boulevard lighting where the overhead wires and unsightly wooden poles are usually objectionable.

The four elements of the series lighting system are then: (1) The transformer. (2) The switchboard for controlling the same. (3) The transmission line, and (4) The lamp and receptacle. The transformer has already been described, and in Fig. 1 the front view of a typical series switchboard controlling two circuits is shown. Fig. 2 shows the general scheme of circuits and is self explanatory. The primary switch can be either an oil switch with trip coils or the less expensive and just as serviceable, primary plug switch.

LINE CONSTRUCTION FOR SERIES SYSTEM.

In regard to installation of service lines for this type of installation, No. 8 B & S weatherproof wire is sufficiently large to transmit economically 6.6 amps. The general practice however is towards the use of No. 6 on account of its greater tensile strength. As the current is constant the line loss is increased directly as the length of the line and is constant for any load. The length of the line depends upon local conditions such as the layout of the town, and the number of lamps in a circuit. No. 6 B & S gage wire has a resistance of 0.40 ohms per thousand feet, while No. 8 has a resistance of 0.64 ohms per thousand feet. Assuming a case where the secondary current used is 6.6 amps and that four miles of wire is required to reach the farthest lamp on the circuit and return, which length of line depends upon local conditions, the line loss for No. 6 B & S wire, with 6.6 amps would be 4 × 5280 × 6.6 × .39 ÷ 1000 = 55.7 volts drop.

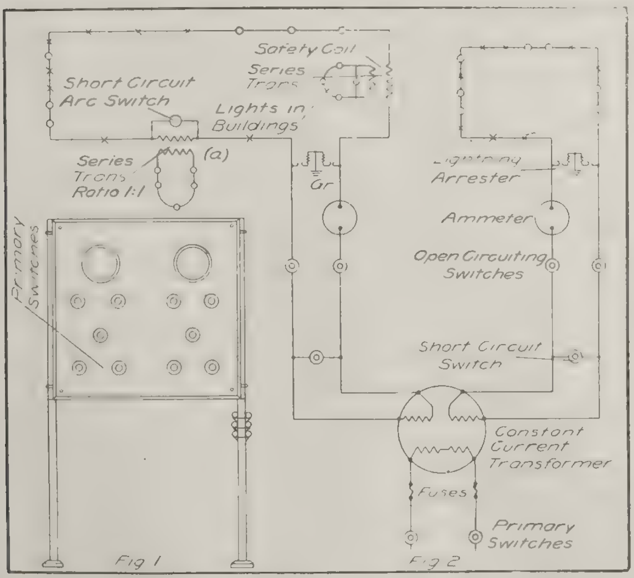


FIG. 1. TYPICAL SERIES LIGHTING SWITCHBOARD.
FIG. 2. GENERAL SCHEME OF CIRCUITS FOR SERIES LIGHTING.

From the accompanying table the voltage as given for the class of lamps we have determined on should be noted and the sum of these different values, plus the line drop will determine the voltage required at the terminals of the regulator in the plant. It would be well to increase this value slightly, say 10 per cent, to allow for future additions to the circuit without re-designing the line. With all incandescent lamps on a circuit, the power factor of the circuit will be unity, and the line wattage will equal the line voltage multiplied by the line amperage. With arc lamps cut in on the circuit however, these two factors will give the kilovolt amps. but not the line wattage, owing to the power factor of the lamps.

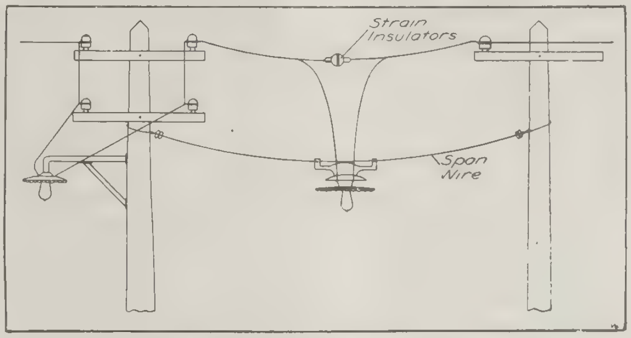


FIG. 3. SHOWING USE OF SUSPENSION TYPE FIXTURE.

The number of lamps to install on a circuit is influenced by local conditions, such as the total number of lights desired, the importance of some particular section, the distance covered to reach each lamp and the class of service. It would not be wise to put all the lights in town on one circuit as an accident to this one wire would throw the whole town in darkness, thus each of the points enumerated above would have to be considered carefully. If the number of lights to be installed would only constitute a sufficient load for one 5000 volt circuit, it would not be the best policy to run all of the lamps on one circuit. Two 2600 volt circuits would be the better choice in this case. Also in deciding on the number of lamps on a circuit and the route and length of the line, selection should be such that an accident to one line will not cut out all of the lamps in one section. If the cost is not prohibitive alternate streets should be fed from different circuits. In some towns local ordinances may prohibit the high voltage when the secondary voltage would have to be changed accordingly.

If in the extension of circuits new poles are to be set 25 or 30 foot poles would be sufficiently tall. These poles should be set in the ground about 5½ feet and should not be spaced over one hundred feet apart. If there are no other wires on the poles, insulator pins would give sufficient insulation, although a two pin cross arm would be better construction. On poles with other wires the arc line cross arms should be carried on the highest gain.

SUSPENSION OF STREET LAMPS AND BUILDING SERVICE.

There are three methods in vogue for the suspension of incandescent lamps. The ornamental pole type, with ornamental bracket which may be attached to the wooden pole and the center span suspension fixture for street intersections and locations where the cost of an ornamental pole would be excessive. Fig. 3 shows the use of the suspension type fixture for location between adjacent poles. A good average height of the lamp above the ground is between twelve and fifteen feet. This may be modified somewhat to fit in with particular conditions.

There are many cases where the series lines run near some isolated building and it is desirable to have electric lights in the same, but where the cost of running a multiple line might be prohibitive. In this case the series system would suit admirably. A small series transformer or safety coil can be cut in on the line, and the line amperage or whatever amperage may be desired, depending upon the transformer ratio, supplied to the building. Or the arc lines may be run directly into the building. In both cases however, a series cut out or loop switch must be installed and the underwriters' requirements strictly adhered to. Fig. 2a illustrates this construction. This same method is used for underground distribution to an ornamental lighting system. The voltage strain on the cable system would then be equal to sum of the voltage drop across each lamp of the secondary circuit, plus the line loss. Each lamp fixture should be equipped with a series socket with an automatic cut out, the action of this cut depending upon the puncture of a thin brass disc should the lamp filament break.

CALCULATION OF ILLUMINATION.

The calculation of illumination at different distances from the lamp and with different lamp heights in a rough graphical way is simple. This intensity of illumination is expressed in foot candles on a surface normal to the rays from the lamps. Knowing the candlepower of the lamp the illumination can be calculated by a general law expressed by the following formula $F = C \div D^2$, where, F = foot candles; C = candle power in the direction of the given point, upon which the illumination is to be determined; and D = distance in a straight line to the point. C and D which must be determined to solve the equation, may be obtained either by calculation or graphically.

The photometric curve for the particular type of lamp and reflector can be obtained from the publications of lamp manufacturers. To illustrate, assume the lamp to be 12 feet from the ground and the distance to point 48 feet. Some convenient scale is assumed and a right angled triangle is constructed with its base equal to 48 feet and with 12 feet, the height of the lamp, as its altitude, the hypothemus D which is the straight line distance to the point A is found either graphically or by calculation to be 49½ feet. The photometric curve is now superimposed on the sketch and the points X and Y where the line D cuts the curve will give the candle power at that particular angle below the horizontal. Fig. 4 illustrates this graphical method.

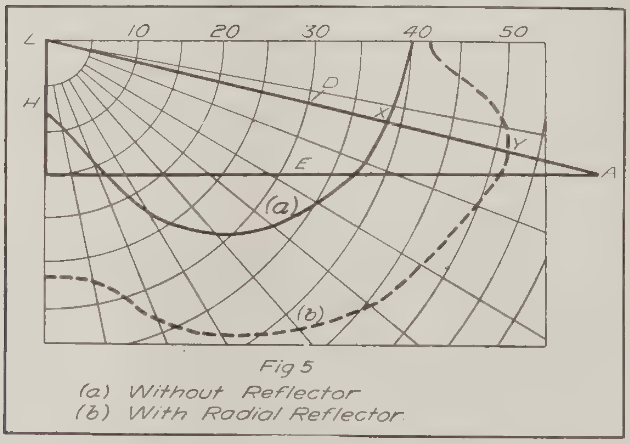


Fig. 4. Light Distribution Curve for an Incandescent Lamp With and Without Reflector and Graphical Method of Determining Intensity of Street Illumination.

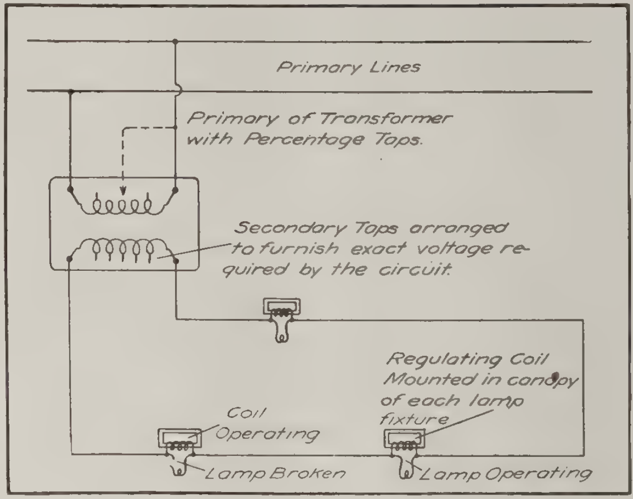

Primary Lines
Primary of Transformer with Percentage Taps.
Secondary Taps arranged to furnish exact voltage required by the circuit.
Regulating Coil Mounted in canopy of each lamp fixture
Coil Operating
Lamp Broken
Lamp Operating

Fig. 5. Series Circuit Showing Use of Regulating Coils in Lamps.

Assuming that this value is 51, we then have $F = 51/(49\frac{1}{2})^2 = 51/2450 = .0208$ ft. candles with reflector. Again $F = 40/(49\frac{1}{2})^2 = 40/2450 = .0163$ ft. candles without reflector.

In the above discussion the use of the tub transformer as the regulation device was mentioned. There are one or two other types of regulators, which use the same principle of magnetic reluctance for the regulating effect and differ only in their design. This discussion applies to the series D. C. system which uses the series arc machine or the mercury arc rectifier. There is another system which has come into use quite extensively, which avoids the use of any regulating apparatus at the plant. It has the advantage that a series circuit may be cut in from the existing multiple lines wherever it is found necessary. The regulation of this system is inherent with each lamp fixture. In multiple with the lamp socket a reactance coil is connected which in case the lamp breaks shunts the current around the broken filament and holds the regulation at a constant value. This system is illustrated by Fig. 5 which is self-explanatory.

A disadvantage of this system is, that if existing multiple lines are used, switches must be installed at each transformer to turn the lamps on or off. These switches may be either automatically or manually operated. With important circuits, the best policy is to have the circuits under the control of the operator, as in the series system.

Electrical Show at Ohio State University.

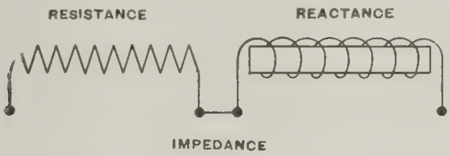
Members of the student branch of the American Institute of Electrical Engineers, at Ohio State University, Columbus, O., have decided to hold an electrical show this year similar to the one held several years ago. It is planned to have exhibits from manufacturers of electrical apparatus and machinery. Plans are well under way and already the manager of the exhibit department has arranged for a large number of exhibits.

Characteristics of Alternating Current Circuits

BY A. H. TIMMERMANN.

Section 2. A Discussion of Resistance and Reactance in a Circuit.

The next circuit to be considered is one containing a combination of resistance and reactance, another name for which is impedance. In a circuit of this character, we say that the total impedance limits the flow of current. If in a circuit containing resistance only, the current is in phase with the electromotive force, and in the circuit containing reactance the current lags 90 degrees behind the electromotive force, then in a circuit containing both resistance and reactance, we would expect the current to lag at some angle between zero and 90 degrees behind the impressed electromotive force. This is indicated in Fig. 8, in which the current lags 45 degrees, that is, the current reaches its zero or maximum values 45 degrees after the electromotive force has reached the corresponding figures.



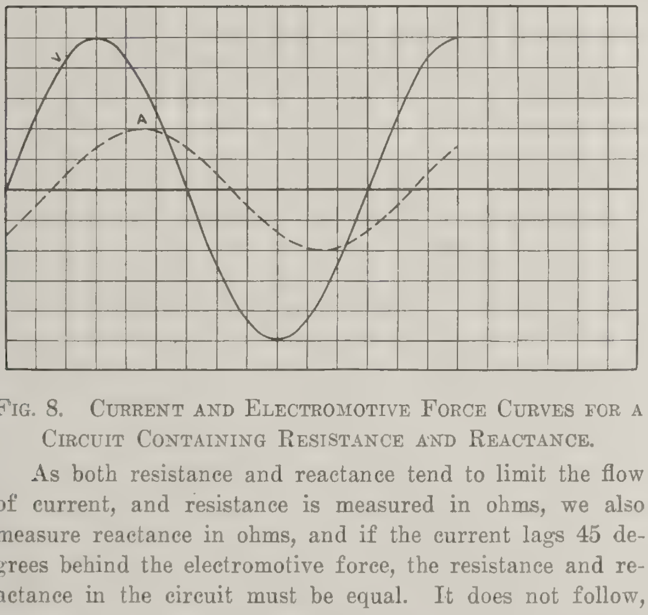


Fig. 8. Current and Electromotive Force Curves for a Circuit Containing Resistance and Reactance.

As both resistance and reactance tend to limit the flow of current, and resistance is measured in ohms, we also measure reactance in ohms, and if the current lags 45 degrees behind the electromotive force, the resistance and reactance in the circuit must be equal. It does not follow, however, from what has been said above that if the resistance equals 10 and the reactance equals 10, that the impedance is equal to 20. It is in fact very much less, and this should be expected because the resistance causes the current to have its maximum value in phase with the electromotive force, while the reactance causes the current to have its maximum value 90 degrees behind the electromotive force. We may say in other words that resistance and reactance have peculiarities which are shown 90 degrees apart and it is for this reason that the impedance in the circuit bears the same relation to resistance and reactance that the hypotenuse of a right angle triangle bears to the two remaining sides. Inasmuch as resistance does not tend to lag the current behind the electromotive force the voltage V_1 across the terminals of the resistance in Fig. 10-B must be in phase with the current passing through that resistance. In other words, if we consider only that portion of the circuit containing the resistance, its current and electromotive force must be in phase. The voltage V_1 must, therefore, lag behind the voltage V, impressed on the whole circuit, by an angle of 45 degrees for the reason that the current lags behind the impressed electromotive force by this angle. With different values of resistance and reactance the angle of the lag would differ from 45 degrees.

Referring now to Fig. 9, curve V_1 shows the electromotive force across the terminals of the resistance in its relation to the impressed electromotive force V. Similarly, as the reactance (Fig. 7) caused the current to lag behind the electromotive force V by an angle of 90 degrees, the electromotie force V_2 (Figs. 9 and 10-B) must lag to 90 degrees behind the current, and the electromotive force necessary to overcome the reactance, or self-induction, as it is sometimes called, must be in advance of the impressed electromotive force by an angle of 90 degrees. In other words, the electromotive force overcoming reactance must be removed 180 degrees from the electromotive force of the reactance. This is equivalent to the statement that if a weight pulls down on a string with a force of 10, the string must pull in the opposite direction, or 180 degrees away, with a force of 10.

A study then of Fig. 9 will show us that the sum of the two curves V_1 and V_2 gives the curve V. That is, the two electromotive forces, V_1 and V_2 must be combined at an angle of 90 degrees in order to equal the total impressed electromotive force V. This is shown in Fig. 10-A, in which A B represents the electromotive force which is used to overcome resistance, B C the electromotive force which is used to overcome reactance, and A C the total electromotive force used to overcome both resistance and reactance, or impedance. This triangle also indicates in general the relations between the impressed electromotive force A C and the current A B, because the current is in phase with the electromotive force which is used to overcome it. In the diagram, then, the angle Θ or 45 degrees in this case, is the

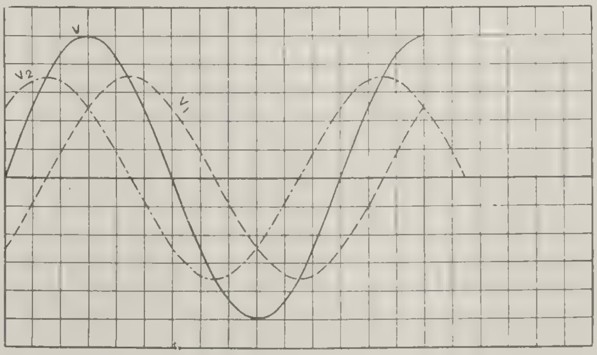


Fig. 9. Relation of Electromotive Force Across Resistance and Reactance to Voltage of Circuit.

angle by which the current lags behind the impressed electromotive force. The cosine of this angle Θ which is equal to A B ÷ A C is therefore

$$\cos \Theta = AB/AC = 7.07/100 = 0.707.$$

The cosine of this angle Θ is called the power factor of the circuit.

The power factor of any alternating current circuit is the cosine of the angle by which the current lags behind the impressed electromotive force.

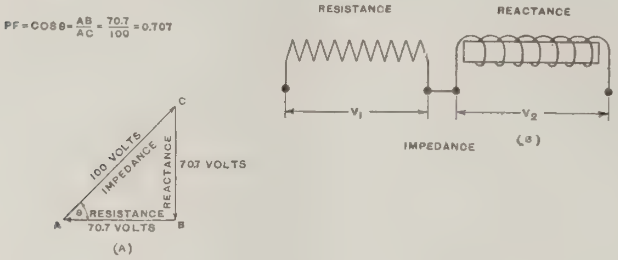


Fig. 10. Showing Vector Addition of Voltages.

It is exceedingly interesting to study the flow of power in an alternating current circuit, as this gives us in fact a very much better idea of what is going on than can probably be obtained by a long discussion of other characteristics of the circuit.

In Fig. 11 we return to our circuit containing resistance only.

The curve V, as before, represents the impressel electromotive force, A the current flowing, and W the watts or power in the circuit at any instant of time. The power curve is obtained by multiplying together the instantaneous values of the current and electromotive force. In the diagram, inasmuch as amperes, volts and watts are different units, the same scale has not been used for all three, the watt scale being very much reduced in size, but taking, however, the value of the current as 40 amperes and the value of the e.m.f. as 100 would give as a maximum value of the power or watt curve 4,000. In such a circuit the mean value of the current (that measured by an ammeter) would be 28.3 amperes, the mean value of the voltage 70.7 volts, and the mean value of the power 2000 watt.

In the circuit as described above whenever the voltage is positive, the current is positive; when the voltage reverses in direction, the current also reverses in direction, and inasmuch as the product of two positive quantities or of two negative quantities is positive the resulting power in the circuit is always positive.

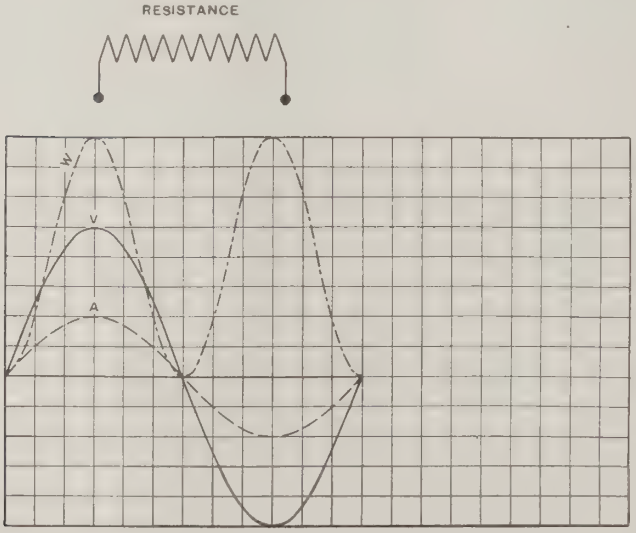


Fig. 11. Curves of Current, Voltage and Power in a Circuit Containing Resistance Only.

If the circuit contains reactance only, as shown in Fig. 12, with the result that the current lags 90 degrees behind the electromotive force, the figure shows that when either the current or electromotive force is zero, the power in the circuit must be zero, with the result that the power reverses in direction twice during half a cycle and four times during one complete cycle, while the current and electromotive force reverse only twice in one complete cycle.

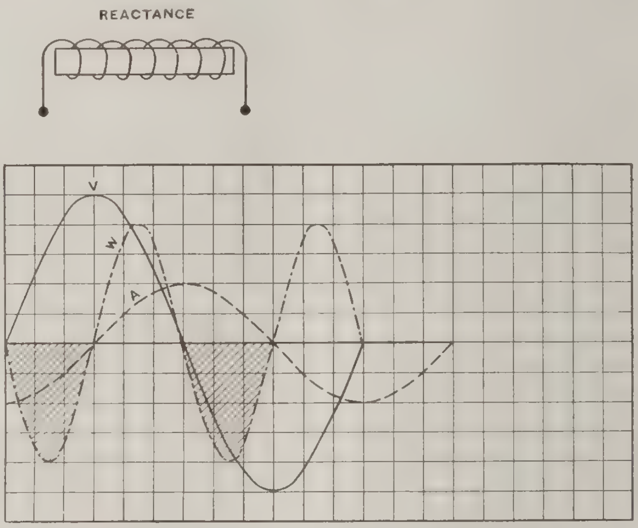


Fig. 12. Curves of Current Voltage and Power in a Circuit Containing Reactance Only.

Another interesting feature is brought out by the fact that the positive power, or power loop above the line is exactly equal to the negative power or power loop below the line. What, then, does this mean? It can mean but one thing, namely, that the total power in such a circuit is zero. In other words, during the first quarter of each cycle the generator is furnishing energy to the circuit, and inasmuch as there is no resistance to use up this energy, it must all be stored up in the magnetic field of the reactance. During the next quarter of a cycle this magnetic field discharges or returns this energy to the generator, so that an alternating current circuit containing reactance only is a circuit in which there is a pulsation of power first from generator to circuit, and a little later from circuit to generator, the total power furnished by the generator remaining zero.

There is still another class of circuit in which the power relations are to be considered, namely, a circuit containing resistance and reactance, or as is generally stated, a circuit containing impedance. These relations are shown in Fig. 13, in which we again have the current curve lagging at 45 degrees behind the electromotive force curve and a power curve again of double frequency which is now partly positive and partly negative. This means that the generator is furnishing power to overcome the resistance and store up energy in the magnetic circuit during a portion of the time only. During the remainder of the time the magnetic field is discharging and furnishing the energy to overcome the resistance, and in fact where the power is negative we have an actual discharge of energy from the magnetic field which is sufficient to not only overcome loss in the resistance, but to actually furnish power to the generator.

From the fact that the generator does not furnish a continuous supply of energy to the circuit and that the circuit sometimes supplies energy to the generator, we often hear the single phase circuit spoken of as the circuit of pulsating power.

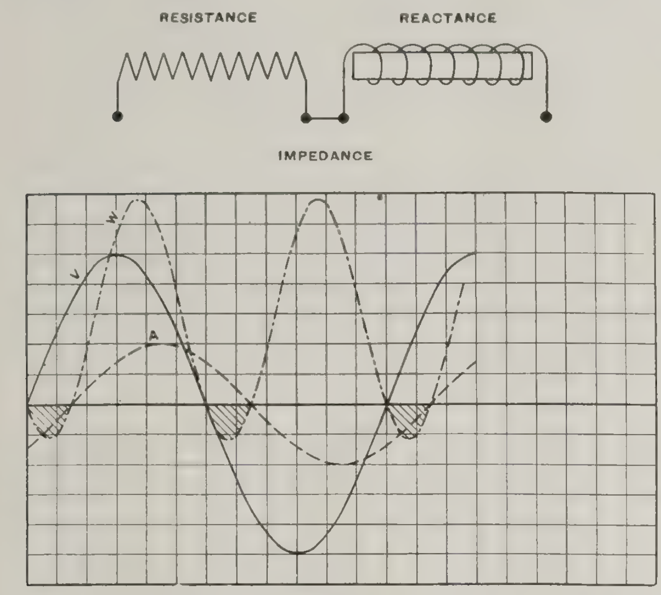


Fig. 13. Curves of Current, Voltage and Power in a Circuit Containing Resistance and Reactance.

This, then, is the general characteristic of the alternating current circuit containing resistance and reactance. We can sum up the whole situation by stating that the resistance element of the circuit, therefore, represents the power transformed in the circuit into heat or useful work.

The measure of power in a single phase circuit is, therefore, equal to that portion of the voltage which is used in overcoming the resistance multiplied by the current flowing in the circuit.

We see from the diagram in Fig. 10-A that this portion of the voltage is only 0.7 in the case under discussion, of the total voltage of the circuit. In other words, the useful portion of the voltage is the impressed voltage multiplied by the cosine of the angle of lag of the current behind the electromotive force, or what is the same thing—the impressed electromotive force multiplied by the power factor of the circuit. We can write then the power in the single phase circuit equals impressed volts times current flowing times the power factor of the circuit. In a particular example, if the current flowing in the circuit was 50 amperes, the impressed voltage 100, and the power factor of the circuit .707, the total power in the circuit would be equal to 50 times 100 times .707 equals 3535 watts, while the apparent power, or volt amperes of the circuit would be 50 times 100 equals 5000. The difference between these two quantities is sometimes called the wattless component of the power, which has no other meaning than that this portion of the apparent power while stored up in the reactance of the circuit during a portion of the time is again returned to the circuit at some other portion of the cycle.

We can now write the relation between the current, electromotive force and impedance in an alternating current circuit, as follows:

$$I = E \div \sqrt{[R^2 + (Lw)^2]}$$

in which R denotes the resistance and the quantity, Lw represents the equivalent resistance in ohms of the reactance of the circuit.

Augusta-Aiken Railway & Electric Corporation Formally Starts Equipment at New Power Station on Savannah River.

On February 16 the Augusta-Aiken Railway & Electric Corporation, of Augusta, Ga., celebrated the completion and starting of a new hydroelectric plant on the Savannah River nine miles above the city of Augusta. A barbecue was given at the plant, served in the old Georgia style, after which the guests returned by special train to the city for turning the current on the city distribution circuits in the evening, following same by a banquet. At this time several speeches were made by visiting guests and prominent citizens of Augusta, including Governor Slaton of Georgia, municipal officials, members of the Merchants' and Manufacturers' Association of Augusta, and representatives of the J. G. White Engineering Corporation of New York, which has done the designing, engineering and construction work on the new project.

The trip from Augusta to the plant was made at the invitation of the Augusta-Aiken Railway & Electric Corporation, and some of those on board the train were: F. Q. Brown, of Redmond & Co., president of the Augusta-Aiken Railway & Electric Corporation and of the Georgia-Carolina Power Company; R. Lancaster Williams, of Middendorf, Williams & Co., of New York and Baltimore, with a party of friends; J. W. Steel, a banker of Philadelphia; the officers and prominent members of the Merchants' and Manufacturers' Association of Augusta; and J. H. Pardee, president, and J. K. Choate, vice-president of the J. G. White Management Corporation. The party was furnished an opportunity to inspect the dam and the power house from which power will be carried to the city of Augusta to supply many mills and industrial plants that have been using steam. This power will be transmitted at 44,000 volts across the Savannah River to feed power to additional mills and industries in the state of South Carolina.

The new plant has an ultimate capacity of 31,000 Hp., the present equipment consisting of five vertical, 3-phase, 60-cycle, 2,300-volt, 2,700-Kva. generators. The dam, including power house, is 2,700 feet long, with an average height of about 30 feet, creating a storage reservoir of 4,000 acres.

Reorganization of Chattanooga Railway & Light Company's Operating Department.

F. W. Hoover, who is general manager of the Tennessee Power Company, one of two companies in the Chattanooga district ready to deliver 150,000 Hp. of hydro-electric power, has been designated executive officer of the Chattanooga Railway & Light Company, with instructions to report directly to M. H. Hopkins, first vice-president of that company. Mr. Hoover is second vice-president of the street railway and light company, having been elected to that office by the directors in Philadelphia some time ago. He was in a position of authority with the Chattanooga Railway & Light Company prior to the resignation of W. E. Boileau as general manager of that company.

E. W. Reed, who has been general superintendent of the Chattanooga Railway & Light Company for two or three years, has been continued in that capacity, though with considerably widened authority. He has been given complete authority in the operation of both the street railway and the light departments of the corporation. While the office of general manager has been abolished, Mr. Reed has practically all the powers formerly exercised by such an office, formerly occupied by Mr. Boileau and has oversight of all departments of the general offices on Market street.

This reorganization of the company in its operating department is spoken of as a centralization of authority in the local business, with a resident executive head that will enable the company to handle all ordinary problems without appeal to the head office in Philadelphia. Mr. Hopkins remains in the same position of final authority he has held since the Clarks acquired the property, while Mr. Hoover continues to be general manager of the Tennessee Power Company, with his offices on the fourteenth floor of the Hamilton National Bank Building.

Data on Southern Central Stations.

According to preliminary data from the Bureau of Census, which is now being arranged for publication in a report covering central station progress in the United States for the period between 1907 and 1912, considerable substantial progress is shown for the South. Some of the data showing the present standing of the different states in number, capacity, output, etc., of stations is given in the accompanying table. These statistics do not include electric plants operated by mining companies, factories, hotels or other plants which consume the current generated, nor plants idle or in course of construction. It will thus be noticed that the capacity indicated for some of the Southern states does not include the capacity of water power stations completed and started during the past two years, which capacity runs into a considerable amount, and will make a similar report in 1917 decidedly more complete and true to conditions. The present report by virtue of the omission of this capacity shows in a fairly adequate way, the present standing of the average Southern central station, and therefore the standing of the various states on this basis.

CENSUS DATA ON SOUTHERN CENTRAL STATIONS.

	Number Stations	Private	Municipal	Station K. W.	Million Kw.-Hrs. Output—1912	Gross Income per Station Kw. Capacity	Per Cent Expense of Income	Gross Income per Kw.-Hr. Sold—Cents	Hp. in Motors	Number of Incandescent Lamps	Per Cent Increase, Lamps 1902-1912.
West Virginia	58	52	6	29,772	42.3	37.4	81.0	2.60	22,925	305,312	291
Virginia	67	53	14	40,512	28.7	18.7	75.0	2.65	8,570	237,079	529
North Carolina	94	46	48	43,099	70.5	31.0	77.5	1.90	32,830	571,384	1,164
South Carolina	61	39	22	132,403	356.7	33.5	63.5	1.25	155,385	268,721	483
Georgia	126	42	84	56,232	87.5	31.4	94.0	2.00	50,633	410,068	581
Florida	50	33	17	23,619	25.9	56.0	80.0	5.10	14,141	367,772	501
Alabama	69	34	35	24,477	48.6	49.5	81.0	2.50	11,148	347,871	466
Louisiana	50	27	23	19,169	18.3	117.5	71.5	12.20	24,557	584,015	330
Mississippi	82	35	47	21,863	27.9	51.5	78.0	4.00	7,955	279,220	228
Texas	253	235	18	84,564	200.4	80.0	72.5	3.40	50,869	1,866,373	514
Oklahoma	130	67	63	28,301	48.8	79.0	84.5	4.60	23,056	592,315	
Arkansas	74	56	18	16,335	17.7	59.0	77.5	5.45	5,283	243,728	196
Tennessee	90	60	30	49,640	75.5	49.5	71.5	3.25	20,357	671,150	285
Kentucky	89	73	16	54,063	75.6	51.0	81.5	3.64	22,621	849,220	495
Total	1293	853	441	624,049	1124.4	745.0	1089.0	54.54	450,330	7,594,228	6061
State Average				44,500	80.0	53.0	77.5	3.8	32,200	542,000	465
Station Average				480	0.87	....	....	....	350	5,850	...

From the table presented here, it would seem that the average station capacity in the South is around 500 Kw., with a gross income per kilowatt of station capacity about $53. The gross income here considered does not include that received from sale of light and power by street railway companies, nor service sold to other public service companies, since such data is presented in a way that makes such a combination very ambiguous and of little value. The table does not give therefore, complete data on stations in such a manner as to derive an accurate value for gross income per station capacity nor for the sam ereason, the percentage of operating expenses to gross income or gross income per station capacity nor for the same reason, columns of the table are therefore only approximate and if anything low as to the first and last items mentioned and high as to the second.

It is to be observed however, that the ratio of expense to income as shown in the table compares favorably with data which has been regularly compiled by the Iowa Electrical Association for the state of Iowa, with the gross income per station capacity about 10 per cent lower than for Iowa. The comparison is however, known to be much closer, as an accurate compilation of total income from the service rendered by combination light, power and railway companies would show. The increase in lighting load for the various states is typical of the progress in all lines during the period which the data covers.

Society for Electrical Development Now Active.

The subscriptions for the carrying on of the proposed work of the Society for Electrical Development have now reached $200,000 and the society by virtue of this fact, as already announced, becomes active. Its campaign for education in keeping with its slogan "Do it Electrically," will soon be in full swing. The membership of the organization has now passed the 1,300 mark, with applications still coming in. With the practical results soon available to support the opinions already advanced, it is certain that the society will rapidly increase its membership and its financial support.

Winnipeg Electric Railway Company (Canada) Plans 40,000 Hp. Hydroelectric Development.

Sir William Mackenzie, president of the Winnipeg Electric Railway Company, has announced that the J. G. White Engineering Corporation, of New York, has been engaged to complete surveys, explorations, designs, plans and estimates for a large hydroelectric development near Winnipeg, Canada. It is understood that the ultimate development will be considerably in excess of 100,000 Hp., and that the immediate development, for which complete designs and plans are to be prepared by the J. G. White Engineering Corporation, will be for 40,000 Hp. Work on the surveys, explorations and designs is to be started immediately and completed as rapidly as possible.

New Business Methods and Results

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

Line Extensions—Spring Business and Appliance Exploitation.

An investigation of the policies in regard to line extensions shows that there is very little if any uniformity in regard to same, for as pointed out by Mr. Macomber in the December number of *Electrical Engineering,* there appears to be as many policies as there are companies. The former practice among many lighting companies, especially among those who had made no study of costs, was to run lines almost anywhere to supply anyone as long as the necessary money could be raised for construction work, trusting in the very vaguest kind of hopes that some time, somehow, the line might prove a paying investment. Naturally as a result of this, a number of the smaller companies have suddenly found themselves in serious trouble, from which many have not as yet recovered. They were not exactly "land poor," but "line poor," for when the line began to need repairs, they found themselves forced, either to continue serving it at a loss, making up the expense from the other customers, which is evidently unfair, or to cut the line off, which would mean trouble, or to raise the rates along the line, which is easier said than done. In general, such a condition is more easily gotten into than out of.

It may be regarded as axiomatic that every business must be self-sustaining and furthermore, that each division of any business should be self-supporting as far as practicable. The general overhead burden should be as small as possible with the fixed charge apportioned to each piece of business wherever at all possible. Failure to do this, as we have before noted, attracts the unprofitable, and discourages the profitable business. While there is a limit beyond which the analysis of fixed charges cannot be carried, yet such charges should be made more accurately than is often done at present.

Each line extension, therefore, should be made profitable in itself, with perhaps two exceptions. In rapidly growing territory where there is a good chance to develop a profitable field, it is not only permissible but wise to make liberal extensions. Furthermore, to avoid appearance of discrimination it is often policy to make all extensions asked for without charge within certain prescribed limits, such as within the borders of a municipality, or other civil division. Public service commissions have often held that adequate accommodations to the citizens of any section within which a franchise is granted, involves giving service to every one within such municipality, no matter where they may be located.

Modern practice in regard to extensions among the larger companies seems to be to handle each application for service on a strictly business basis, carefully estimating the cost of the extension, the present business to be secured and that likely to develop in the near future, and then to make a proposition whereby the cost of the line, above the amount which can be profitably invested by the company, will be financed in whole, or in part by the prospective customer. In these cases the amount the applicant should justly pay and the manner of payment, is largely a matter of private judgment, and on this account wide diversity of practice exists with consequent unavoidable seeming discrimination.

In general there are three ways in which the customer may bear part or all of the construction cost. First, by payment outright, either in cash or monthly payments. Second, by guaranteeing a sufficient amount of business to meet the cost out of the resulting profits on service. Third, by means of a rental charge, to continue as long as the customer makes use of the line. Each of these have both advantages and disadvantages, but the first and third are probably more accurate than the second. The objection to the payment outright, is that it discourages extensions; the advantage being that the company runs no risk of the customer discontinuing service in a short time and leaving a useless line on the company's hands. Furthermore, where the company may extend the line to serve a certain customer and later on other business should be added, the latter can claim and justly, that since he paid for the line he is entitled to the exclusive use of it, or a refund. All this, of course, opens the way to a dispute and consequent ill feeling.

The guarantee plan and the rental plan, render business easier to get, but care should be taken that the parties making application are reliable and responsible, otherwise the extension may prove more of a speculation than an investment. The guarantee system, while much used, is difficult of accurate apportionment, and does not lend itself readily to adjustment.

Probably the simplest and most accurate plan is to rent the line to the customer on a basis such that the rental will cover fixed charges and upkeep, and to sell current at the same rate, and terms as if the csutomer were at the power house door. Then in case business should spring up along the line, the rental should be adjusted and when the customers become so numerous as to make the fixed charges small in proportion to the total business handled, the rental charge would naturally be dropped altogether.

The need for some kind of uniform practice among central stations in this regard has attracted the attention of public service commissions, and the Wisconsin Electrical Association at the suggestion of the Railroad Commission has appointed a committee to investigate the policy of companies throughout the state, and make recommendations towards some kind of uniform practice. While absolute uniformity can hardly be attained, because some personal judgment in the matter will always be necessary, yet there should and can be uniformity of method used in arriving at the results. The same committee is also to take up the question of deposits, cash discounts, and other details of service regulations.

SPRING CAMPAIGNS.

It is not too early to begin to lay plans for spring business campaigns. Last year's performance should be examined to see if it can be improved upon. A company should not be satisfied until every one of its customers is provided with every device for safety, comfort and convenience that can be afforded. Somehow, most companies have the campaign habit which, if not carried to the extreme of neglecting the general run of business, is good policy. There is a psychological reason for it, entirely apart from the primary consideration of seasonableness. When a salesman starts out with a wogon load of irons, and a determination to put one in every house, with "irons on the brain" as it were, he will place far more irons than the salesman to whom the sale of an iron is simply an incidental in connection with other saleswork. His mental condition insensibly affects the mind of the customer. Call it thought-transference or what you will, there is a "swing," a "go" to the campaign, which is lacking at other times.

Proper development of business calls for both steady plodding, and also for seasons of special effort. Some campaigns are "personally conducted," others are wholly built up by advertising. In the latter case, of course, the appeal must be along some special line, for many customers who would never come to a company's show rooms can be brought there by some special offer. Even in the case where salesmen are used there should be extensive advertising, of such a nature that there will be no excuse for any customer remaining in ignorance. It is a great deal easier to say, "Madam, I suppose you have been reading our advertisements in the Daily News," than to explain a proposition from the ground up.

As to actual methods, there appears to be little of value that is new. During the past year we have presented in these columes reports of a number of successful campaigns, which when analysed show that the secret of their success has not been in any specially novel features, but in the application of sound merchandising methods. The main points of any campaign are a good proposition that will impress the public by its value, enthusiasm among employes, and an appropriate time to concentrate sales effort on making the proposition a success. Demonstrations should be used where practicable with courteous attendants, when the public may be expected to do the rest.

It seems appropriate at this time to give a few suggestions regarding the monthly payment plan. Many companies have never tried it and some do not approve of it. A large majority of those however, who have used such a plan find it successful and others are falling into line. Of course, we will always find those who prefer to pay as they go and rather pride themselves on doing so, which is good business, to be discouraged in no way, yet a central station should not shut themselves out of other profitable business which can be secured on the installment basis. Articles can be offered at from 3 to 12 months time and the payments should run from $1.00 per month for an iron up to $5.00 or $10.00 in the case of an electric washer. It is also well to have optional propositions. For instance, an $85.00 washer may be sold in five payments of $17.00 or ten payments of $8.50, etc., as the customer may feel prepared to pay. In general, list prices should be adhered to throughout, and only 6 per cent interest allowed for cash. On account of the extra expense incurred in handling this kind of business, the price should not be cut so low as to leave no profit in the transaction.

In every town, large and small, there are a large number of persons who do not use electricity, whose houses are not wired, and yet who would become customers if properly approached. In many of such cases the value of the electrical appliance as an entering wedge has not been fully realized, at any rate, few instances have been reported where a systematic effort has been made to interest non-users of electricity in electrical devices. To interest such prospects different methods must be used. The average electrical advertisement is simply glanced at by non-users, with the thought, "Oh, well, we can't use that, because we have no electricity." In this case, the thing to do is to take advantage of some appropriate season of the year, such as just before spring house-cleaning, to make a united appeal for cleaners, irons, and washers, making up a carefully selected list of a number of possible customers and sending to each a series of good letters, explaining the use of appliances. Little need be said about light, for in fact, if these people wanted electric light they would probably be using it instead of gas or oil. The probability is that they are satisfied with the light they use and must be interested through a different appeal.

In order to prevent the letter from sharing the same fate as the advertisement, it must be so worded as to gain the prospect's interest and attention. For instance, the expense of installing a couple of receptacles in a kitchen is small, perhaps not over $3.00 or $4.00, and any company can well afford to do this free to introduce an iron, cleaner, washer, or any two of them. Such a scheme as suggested by W. E. Clements, of the New Orleans company, in the February issue, is a good one for this purpose, especially as it is designed with the introduction of appliances particularly in view, and provides a complete portable arrangement for cut in, meter and appliance connection. With such a scheme, a letter could be started, "We wire your house free," and go on to explain the proposition. As a matter of fact, when it comes to putting in such equipment the average person will want some additional lights, and in many cases this will serve as the entering wedge for an order to go ahead and wire the whole house, even though the original proposition was not made on the basis of any light at all.

FREE LAMPS.

"To give or not to give," is the question, and it is a question which apparently will not be downed. It is said that no question is settled until it is settled right, and if such is the case with this question of free renewals, it will probably result in their end, for the electrical contractors and supply houses persistently insist that this is part of their rightful business. While there are good arguments on both sides, it is certainly a fact that the present situation was forced upon the central station on account of the wide variation in lamp quality prevalent in the early days of the industry, and the necessity for a reliable source of supply of lamps of proper efficiency and voltage.

This argument is of much less weight today, due to the standardization of lamps and the general use of the tungsten unit. Some companies furnish free tungsten lamps, in certain sizes, but the practice is not general, and perhaps never will be, for it is certain that the introduction of the most efficient units is greatly retarded as long as one type is sold and the other is given away, so that in the end it will be quite probable that they will both wind up on the same basis, either both sold or both free. If customers had to buy carbon filament and gem lamps, they would very quickly begin to buy the tungsten unit.

A. G. Rakestraw.

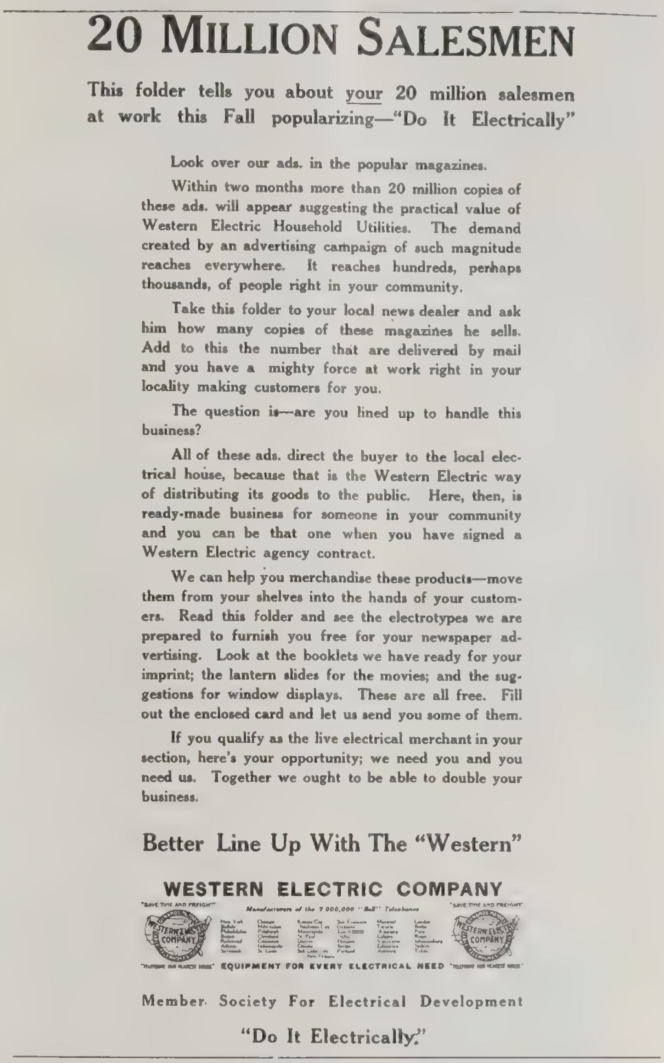
Here is something worth remembering: "Tac"-t is something that is used to hold a thing up you don't want to fall down; one kind you drive in, the other you must not.

Educational Work in Electrical Merchandising.

Considerable criticism is frequently heard of methods of merchandising used by retailers of electrical goods. From time to time expressions have appeared in these columns presenting some of the reasons for the present situation, together with expressions coming from the electrical jobbers and dealers themselves. From these comments it is plain that considerable interest is now shown in merchandising methods that tend to create more business and more substantial business. The work of organized interests along these lines is serving as a valuable stimulant, notably the work of the National Electrical Contractors' Association, the National Electric Light Association, and the proposed work of the Society for Electrical Development. All of these agencies recognize that exploitation methods in connection with the handling of electrical apparatus are yet crude; that the interests responsible for the local sale of electrical goods must have co-operation and support from the larger interests, and that the extensive missionary work for creating a demand for such products, among consumers whose knowledge of same is as yet very meager, must be borne by all jointly.

As in other lines of new business, electrical merchandising in the South has traveled the paths of least resistance. The electrical contracting and electrical supply business has, in the main, been carried on in the past by one and the same concern, the former work being done by day and the latter largely by night. This has been due primarily to the demand for electrical wiring, the extension of transmission lines and the wiring of buildings before electricity could be utilized. Thus the majority of contractors and central stations have concentrated their interest on this work, permitting the electrical merchandising end of the business to remain a side line. At present, therefore, the territory of most central stations in the South is flooded with trained and experienced wiremen, but few business men—few trained and experienced electrical merchandisers. Today construction work in the majority of towns and cities has reached a point where electrical merchandising has a different aspect, and where conditions must be changed to properly further a substantial growth of the electrical industry. Careful thought and special attention must be given the conditions necessary to the loading of distributing lines and the exploitation of those devices for which there seems to be an ultimate and attractive demand. As yet the central station has taken the initiative in this work, and in those cases where considerable activity has been shown, even in competition with the electrical dealer and contractor, it cannot be denied that considerable good has resulted principally from the practical demonstration of the business which has remained dormant, due either to financial conditions or other inability on the part of electrical dealers and contractors to realize the situation that lay at their very doors.

It is everywhere recognized that the electrical jobber and dealer has a legitimate place in this development work and in the handling of electrical supplies, and we take this opportunity to present an excellent example of educational work being done by a large distributor of electrical apparatus on its own account and as a representative of a number of manufacturers. This company has branch houses located throughout the United States, all of which carry out carefully laid out exploitation plans in connection with regular sales work. The nature of this work is such as to be a good stimulant to the electrical supply business, and besides being legitimate and wholesome in every way, as far as securing connections for themselves is concerned, it is a work that will aid others and competitors on account of the good principles on which it is based.



20 MILLION SALESMEN

This folder tells you about your 20 million salesmen at work this Fall popularizing—"Do It Electrically"

Look over our ads. in the popular magazines.

Within two months more than 20 million copies of these ads. will appear suggesting the practical value of Western Electric Household Utilities. The demand created by an advertising campaign of such magnitude reaches everywhere. It reaches hundreds, perhaps thousands, of people right in your community.

Take this folder to your local news dealer and ask him how many copies of these magazines he sells. Add to this the number that are delivered by mail and you have a mighty force at work right in your locality making customers for you.

The question is—are you lined up to handle this business?

All of these ads. direct the buyer to the local electrical house, because that is the Western Electric way of distributing its goods to the public. Here, then, is ready-made business for someone in your community and you can be that one when you have signed a Western Electric agency contract.

We can help you merchandise these products—move them from your shelves into the hands of your customers. Read this folder and see the electrotypes we are prepared to furnish you free for your newspaper advertising. Look at the booklets we have ready for your imprint; the lantern slides for the movies; and the suggestions for window displays. These are all free. Fill out the enclosed card and let us send you some of them.

If you qualify as the live electrical merchant in your section, here's your opportunity; we need you and you need us. Together we ought to be able to double your business.

Better Line Up With The "Western"

WESTERN ELECTRIC COMPANY

"SAVE TIME AND FREIGHT"

Manufacturers of the 7,000,000 "Bell" Telephones

EQUIPMENT FOR EVERY ELECTRICAL NEED

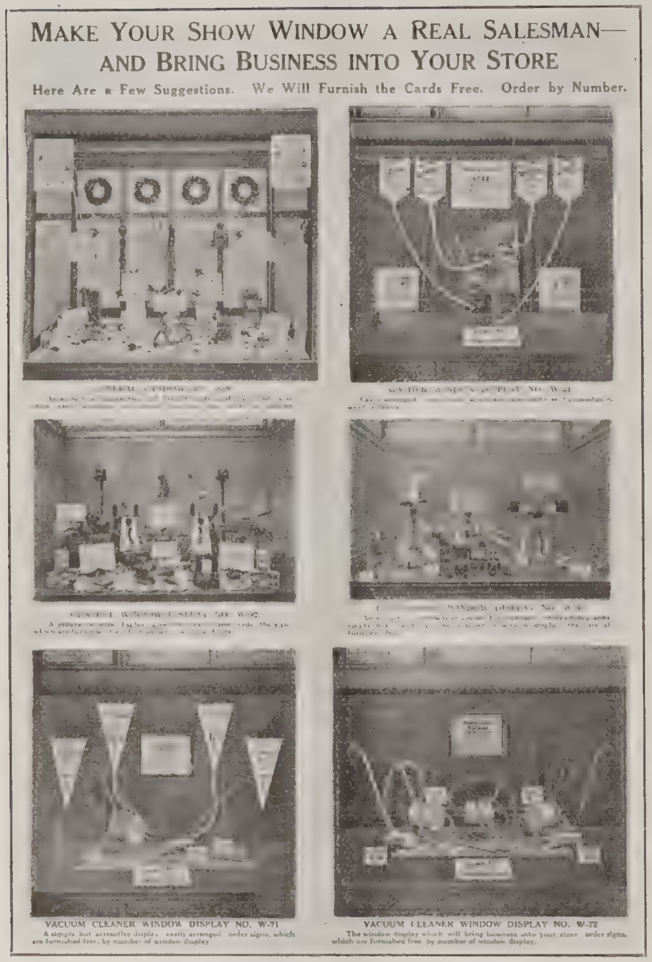
Member Society For Electrical Development

"Do It Electrically."

FIG. 1. THE MESSAGE OF AN EDUCATIONAL FOLDER SENT ELECTRICAL SUPPLY DEALERS.

Further, the character of educational work being done and business being created is a good example for every central station manager, since the policy of co-operation with local dealers and contractors can be carried out in a similar way in local sections, and the work of exploitation of electrical apparatus placed on a substantial basis from which results, in the natural order of affairs, will result first to manufacturer, next to jobber, then to dealer, and last to the central station through connection of the current-consuming apparatus to existing lines. Already, in the South, such a spirit of co-operation has started and will continue to gain ground as merchandising methods among jobbers, contractors and dealers improve.

The illustrations shown here are taken from literature now being sent out by the Western Electric Company in circularizing the field of its different branches. Fig. 1 is a convincing argument that this company has confidence in the future demand for electrical products, and indicates that a liberal amount of money is being spent for creating such new business. Fig. 2 shows a very commendable way



MAKE YOUR SHOW WINDOW A REAL SALESMAN—AND BRING BUSINESS INTO YOUR STORE

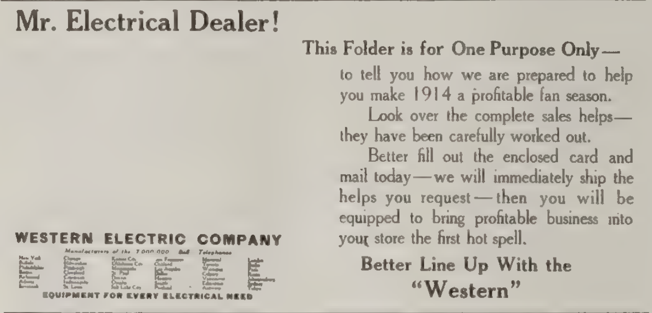
Here Are a Few Suggestions. We Will Furnish the Cards Free. Order by Number.

VACUUM CLEANER WINDOW DISPLAY NO. W-71
A simple but attractive display, easily arranged; order signs, which are furnished free, by number of window display.

VACUUM CLEANER WINDOW DISPLAY NO. W-72
The window display which will bring business into your store; order signs, which are furnished free, by number of window display.

FIG. 2. SUGGESTIONS IN WINDOW DISPLAYS THAT HELP THE OTHER FELLOW.

of educating dealers in the use of an asset possessed by each and every one—namely, window space. The message in Fig. 3 is one presented through a folder announcing possible fan business for 1914. This folder is unique in character, being a pictorial presentation of the possibilities for selling electric fans, including methods for creating this business. The illustration in Fig. 4, shown here, suggests a window display for which the Western Electric Company furnishes not only details for complete construction arrangements, but all necessary ribbons, stickers, display cards and artificial snow. Further, another page of the folder shows six attractive lantern slides prepared from living models that can be furnished for use in moving picture theaters, which slides may present the name of the dealer or other advertising message. This co-operation is made possible at no cost, together with numerous other sales helps and hints that are suggested in the folder. Such a proposition, presented as this one is, certainly makes the Western Electric Company a very attractive jobber to electrical dealers. This is only one of many cases where manufacturers and distributors are helping along the movement for better merchandising in connection with the solicitation of business, and certainly such schemes have much to commend them.



Mr. Electrical Dealer!

This Folder is for One Purpose Only—

to tell you how we are prepared to help you make 1914 a profitable fan season.

Look over the complete sales helps—they have been carefully worked out.

Better fill out the enclosed card and mail today—we will immediately ship the helps you request—then you will be equipped to bring profitable business into your store the first hot spell.

Better Line Up With the "Western"

WESTERN ELECTRIC COMPANY
EQUIPMENT FOR EVERY ELECTRICAL NEED

FIG. 3. AN INTERESTING MESSAGE CONVEYED BY AN EDUCATIONAL FOLDER ON FAN POSSIBILITIES.

This idea of good merchandising is not only being given attention by electrical distributors in advertising literature,

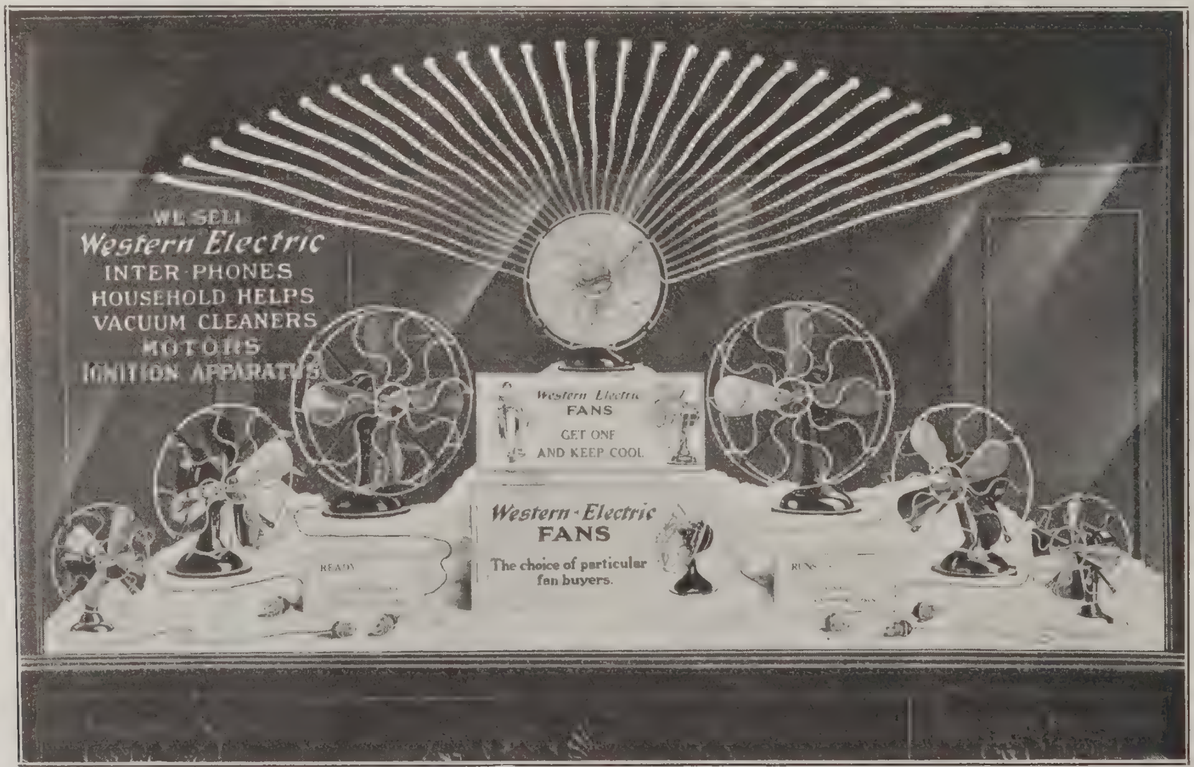


FIG. 4. A SUGGESTION FOR A WINDOW DISPLAY WHERE THE DEALER IS CALLED ON TO FURNISH ONLY LABOR FOR ARRANGEMENTS.

but through their traveling representatives. At a sales conference in Atlanta last month, P. L. Thompson, advertising manager of the Western Electric Company, stated that "The man who today represents a company and writes orders only is a 'peddler,' and the man deserving of the term 'salesman' must be an electrical merchandising specialist—a man capable of making suggestions that will create business for the party solicited, which will, in turn, secure more business for his company. Ability must be possessed to plan new business campaigns; window displays; suggest and make new arrangements, as well as be able to advise in regard to other details necessary to successful merchandising of electrical equipment." With salesmen of this caliber canvassing the electrical supply trade of the country and preaching sermons on good merchandising, it is certain that some direct good will result and the commercial end of the electrical business assume its rightful position among other commercial pursuits of the present day.

COMMENTS FROM READERS.

R. L. Lindsey, General Manager of Durham Traction Company, Outlines Methods for Boosting Business and Stimulating Public Good Will in Durham, N. C.

In March, 1913, the Durham Traction Company organized a "new business department," with George B. Barnett, manager, from Warren, Ohio, and four representatives—C. L. Dunn, of Bristol, Tenn., Lee Goodwin, from our company's meter department, F. M. Morgan, from our house wiring department, and M. S. White, formerly of the North Carolina Public Service Corporation at Greensboro, N. C. The department was organized along the lines of the Doherty Opening Company's policies, the Traction Company having been purchased early in 1913 by Henry L. Doherty & Co., 60 Wall street New York. Regular systematic campaigns were inaugurated to stimulate the increased use by present customers and the securing of new customers for electric light, power and electric appliances.

The first campaign of the year was for electric signs, and we were able to secure orders for several good signs of strong character and individuality. The next campaign was for new house wiring contracts, and in one month, with four representatives, we secured more than one hundred contracts. This was followed by a campaign for exhaust, ceiling and desk fans, and the result was a sale of more electric fans than in any three former seasons. Again we repeated our sign campaign, securing a goodly number of orders for electric signs of a gratifying quality and design. Each campaign was prefaced and supported by strong and effective newspaper advertising, in addition to personal work by our efficient corps of representatives.

Our company maintains its own wiring department, consisting of a storekeeper and clerk and twenty house wiring electricians. It will thus be apparent that during all campaigns of whatever nature that some effort had to be made and a considerable number of house wiring contracts secured daily, to keep this large force busy. During the year our new business department with these methods and systematic intelligent work have secured 33⅓ per cent additional customers.

While our main aim has been to wire all old houses on our present lines, and to increase current used by present customers, it is gratifying to report that while there have been erected many business buildings and residences during the past year, we have not failed to secure a contract for straight electrical equipment in a single one of these buildings. We have also secured an electric installation in every business house and residence in the city that was remodeled during the year, some of which previously used other methods of illumination.

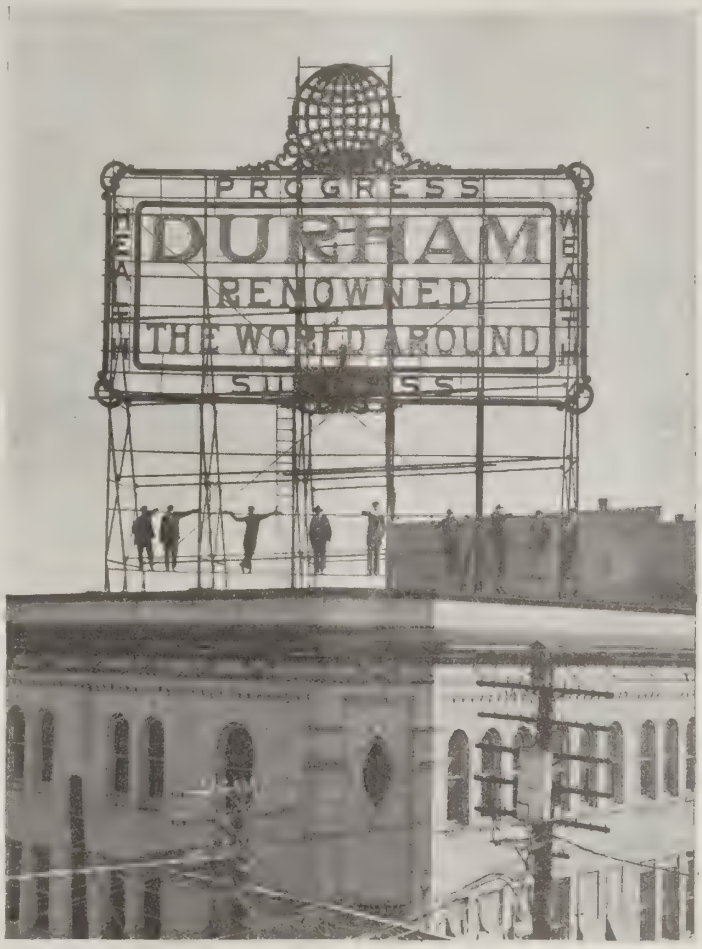


FIG. 1. SLOGAN SIGN PRESENTED TO CITY OF DURHAM BY DURHAM TRACTION COMPANY.

For the purpose of advertising our city, we proposed a gift to the City through our Commercial Club of a large slogan sign, free from maintenance and operation costs. A prize contest for slogan phrases was then put on and thousands of phrases secured. The selection of a slogan was made by a Committee and much publicity and good feeling secured thereby. The slogan sign was scheduled to be lighted December 15th, and an "electric holiday carnival" of fifteen days was promoted to begin on this date, all with an idea of benefiting our local merchants by increasing their holiday trade. We have a census population of 18,241 and at the opening of the Carnival and initial lighting and presentation of the slogan sign, we had an attendance on the streets of more than 12,000 people, and the merchants reported the most gratifying sales of their business experience.

Throughout all this work we have endeavored to stimulate and increase a friendly spirit of co-operation between our public and Company, and believe we can say without fear of successful contradiction that there are few, if any, public service corporations that enjoy a finer feeling than that existing between the citizens of Durham and the Durham Traction Company.

Thomas F. Campbell, Electrical Engineer, Duquesne Light Company, Outlines Policy of Company on Lamp Renewals Before Pittsburg Section of Illuminating Engineering Society.

Poor lamps, prior to the advent of free lamp renewals, were the cause of most poor light complaints. The extension and growth of electric lighting service has been assisted by its improvement resulting from the free renewal of lamps, and several of the advantages accruing from this policy comprise the removal of the objectionable features which produced poor service. In the first place, where the customer renews his own lamp he seldom if ever does so until the lamps actually burn out or are broken. The fact that a lamp has deteriorated 50 per cent in candle power is never considered, with the result that the customer would use gas rather than the poor electric light. The depreciation with continued use, being gradual, is not noticed, and this fact, added to the common opinion that electric light needs no attention, is largely responsible for the little concern given the condition of lamps. With renewals gratis, however, this element is largely eliminated; the customer's lamps are kept in good condition and he gets full rated candle power, or nearly so.

An equally important improvement is brought about when the central station furnishes the lamps, because in this way the rated voltage of the lamps supplied can be made to correspond with the voltage maintained. From a standpoint of good service, this is necessary, as it keeps the customer from using lamps of higher or lower rated voltage than that of the circuits. As mentioned before, the candle power of all incandescent lamps is greatly affected by a change in voltage. Lamps rated at from 100 to 130 volts have been used on 110-volt service, with the result that some customers had good light and frequent lamp renewals, and others poor light and few renewals, depending on rated voltage of the lamps.

Supplying lamps to the customers at a standardized voltage has proven to be of educational value which has been utilized since the tungsten lamp has come into general use. We find in nearly every case the rated voltage of tungsten lamps (which the customer buys himself) is the same as that rated on the lamps supplied by the central station. As an advertising scheme for the promotion of new business, free lamp renewals serve as an inducement to prospective customers and also to encourage the increased use of electric lighting by old customers. When first established this policy was resented by some, who were suspicious of the company's motives, but as it became better understood its popularity increased. It is now recognized as an important part of central station service, and nearly all residence customers rely on this means of lamp maintenance.

The Duquesne Light Company furnishes only metallized filament lamps of the highest efficiency, every one of which has been inspected and photometered previously. The cost of renewing lamps, including all expenses of handling the lamps in addition to the cost of lamps themselves, has averaged $3.32 per installation renewed, and the number of lamps supplied amounts to about 500,000 per year.

In regard to the free renewal of tungsten lamps, many of the previously mentioned statements could be applied as arguments for its adoption by central stations now renewing metallized filament lamps. Some central stations do renew tungsten lamps free under certain restrictions, but the general practice is to furnish the customer with these lamps at something less than list price. The free renewal of tungsten lamps would probably increase the cost of renewal per installation to about $7.00, and it is questionable, indeed, if the increased maintenance charge would be justified. Contrary to the general opinion, many residences under present conditions are served with electric current at a loss to the central station. That is, the yearly revenue is less than the sum of cost of maintenance, interest and depreciation on investment incidental to the particular installation, and the cost to the central station of the losses in lines, transformers and meters.

The great economy of tungsten lamps has proved to be a sufficient incentive to their use, and during the past two years they have come into general use in both large and small residences. From the central station's point of view, the effect has been one of improved service, and, in general, has not reduced the revenue on account of the increased use of the current due to the satisfactory illumination.

Chicago Meeting of N. E. L. A. Commercial Section Executive Committee.

During the year the executive committee representing the Commercial Section of the National Electric Light Association has been very active. With some half dozen committee meetings and a number of sub-committees at work on various important commercial matters, the organized effort and results of same to be reported at Philadelphia in June of this year promise to be in keeping with the trend of commercial progress throughout the country.

On February 14 the executive committee met in the Hotel Sherman, Chicago, with the following members present: T. I. Jones, chairman, of Brooklyn; E. W. Lloyd, Chicago; E. L. Callahan, Chicago; William Rawson Collier, Atlanta; C. A. Littlefield, New York; J. C. McQuiston, Pittsburg; N. H. Boynton, Cleveland, and F. B. Rae, New York.

Mr. W. R. Collier, sales manager of the Georgia Railway & Power Company, of Atlanta, as a member of the committee, reports an interesting meeting and important work done, including plans for revising the solicitors' handbook so as to make it pocket size and take a standard form of data sheet. The training of salesmen and the matter of general publicity work through existing section publications were also discussed. A scheme for presenting a merchandising handbook was also taken up, which should treat the sale of apparatus and service in a broad and general way, and in addition, give the essential details necessary to efficiency in commercial solicitation, office and storeroom work. The work of the committee will now be rushed into final form for report at the annual convention.

Production of Tungsten in 1913.

Tungsten ores were produced during 1913 in six of the western states—Colorado, California, Idaho, Arizona, South Dakota and Nevada. According to preliminary figures collected by Frank L. Hess, of the United States geological survey, the production showed an increase over that of tungsten trioxide (WO_3), and was valued at about $640,500. each of the two preceding years. The output for 1913 was equivalent to 1,525 tons of ore carrying 60 per cent of tungsten trioxide and was valued at about $640,500.

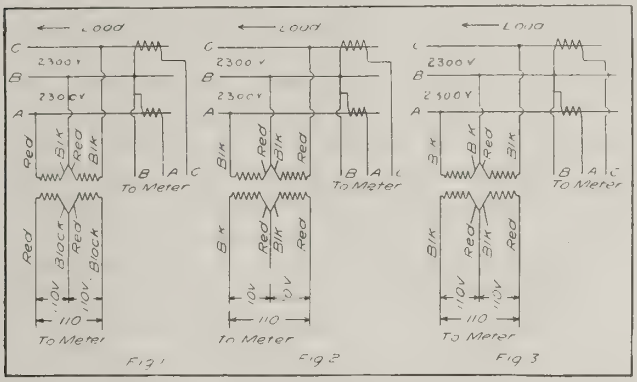
Questions and Answers from Readers

Readers are invited to make liberal use of this department for discussing questions, obtaining information, opinions or experiences from other readers. Discussions and criticisms on answers to questions are solicited. However, editors are not responsible for correctness of statements of opinion or fact in discussions. All published answers and discussions are paid for.

METHOD OF CONNECTING POTENTIAL TRANSFORMERS FOR SWITCHBOARD INSTRUMENTS.

Editor Electrical Engineering:

(438) In connecting up some switchboard instruments using two 100 watt 2300/110 volt potential transformers in open delta, for the potential connections to all the meters on four generator panels and the three feeder panels, I connected transformers as shown in Fig. 1, and the meters had a tendency to rotate backwards. I then changed the connections as shown in Fig. 2, with the same results. Next, I changed the connections as shown in Fig. 3 and secured the correct readings of meters. Please explain the different phase relations for the different connections shown.



Please explain what is meant by the instruction tag on transformers having one red primary and one red secondary lead. Does the red lead show relative instantaneous direction of current in the transformer? Also, when connecting polyphase wattmeters one element at a time for positive indication, why does one element read low?

T. C. M.

GLASS VS. PORCELAIN HIGH TENSION INSULATORS.

Editor Electrical Engineering:

(439) It is understood that some of the glass insulator manufacturing companies are producing a type of glass high tension insulator designed for the same service that porcelain suspension types are now used. It is claimed that these types are now in service on lines of 110,000 volts and meeting conditions in a satisfactory manner. If any readers of *Electrical Engineering* are using these insulators on their lines, or know of any use of same, I would like to see in your columns a discussion of the merits of these insulators for high tension work. The way in which these insulators stand high tension disturbances, strains and short circuits will be of especial interest.

P. R. P.

AIR TANKS VS. AIR COMPRESSOR OUTFIT FOR ELECTRIC INTERURBAN CARS.

Editor Electrical Engineering:

(440) Please favor me with information in answer to the following questions: (1) What interurban electric roads are using tanks of compressed air instead of individual compressors on each car for breaking? (2) What method is used for charging the tanks? (3) What are the merits of the system?

S. H. C.

CHANGES IN EXCITER FOR USE WITH ALTERNATOR OF INCREASED VOLTAGE.

Editor Electrical Engineering:

(441) The writer would be glad to see a discussion in your columns on the problem:

A type A General Electric 133 cycle generator, formerly wound for 1,100 volts, was struck by lightning and armature had to be rewound. It was rewound for 2,300 volts and an exciter used. Shortly after, the commutator became short-circuited and was cut out, allowing the exciter to do full exciting, as generator had a very light load. The load has since increased, and full capacity of 125 Kva. is now wanted. What changes would have to be made? Should the commutator be rebuilt and connected as formerly, and, if so, would this give full rating, since voltage has been raised from 1,100 to 2,300 volts? What changes would be necessary to use the exciter on the series field coils as well as the coils now in circuit with it?

A. O. DeA.

PARALLELING COMPOUND AND SHUNT WOUND D. C. GENERATORS.

Editor Electrical Engineering:

(442) I would like to know if it is possible to operate in parallel a 100 Kw., 220 volt, compound wound generator and a 50 Kw., 220 volt, shunt wound generator with a Tirrell regulator. The Tirrell regulator is to be used to keep the voltage of the shunt machine regulated. Can these machines be paralleled so as to give satisfaction? If it is possible, please give diagram showing the proper connections.

We have a 25 Kw., 110 volt, shunt generator, but do not know the make of this machine, as the name plate is lost. We want to compound this machine, but do not know the number of turns on the shunt winding. Is there any way of figuring the number of turns to use on the compound when the number of turns on the shunt is not known?

L. H. W.

STEAM HEATING BY CENTRAL STATIONS.

Editor Electrical Engineering:

(443) The writer would like to get an expression from Southern central station readers of *Electrical Engineering* as to the attractiveness of a steam heating load in the average sized Southern city. Any suggestions, comments or experience from those who are furnishing steam heat will be considered of value. About how many Southern stations carry any such load?

W. F. G.

COST OF STEEL TRANSMISSION LINES.

Editor Electrical Engineering:

(444) Please request that some reader submit data on the cost of constructing a double circuit steel transmission line for 11,000, 66,000 and 110,000 volt operation. I would

like the data to include cost of towers, insulators and clamps, and the labor necessary to assemble towers, lay foundations and erect them. Cost per installed tower or per mile of line is desired for each item. The spacing can be taken as suitable for a fairly level country.

G. S. M.

A Review of the Present Fuse Situation. Ans. Ques. No. 398.

Editor Electrical Engineering:

Referring to an article by Mr. McIntoch in answer to question No. 398, in the November, 1913, issue of *Electrical Engineering,* and to Mr. J. C. Kahl's article in the December issue, the writer offers the following:

When the question, "What is wrong with the refillable fuse?" was propounded, the reader probably thought it could be answered in a very few words—but not so. He has probably read the pros and cons in the issues that followed, and he probably is as yet not convinced. He cannot decide either way until he considers the situation from a psychological point of view, together with its electrical considerations.

Mr. McIntosh, in his article, "The Essential Features of the Present Fuse Situation," published in the November issue, outlined the situation clearly in the second and third paragraphs, which, for emphasis, I would repeat here:

"First: To the lay mind the fuse is a very simple device and one not requiring any study or skill in its manufacture or any care or attention after it is installed. To those having to do with the fire hazard, however, the fuse is a highly important device and one that needs extreme care in its manufacture and use to properly come within the meaning of the phrase 'a protective device.'

"Second: To the manufacturer who complies with the code requirements the fuse is a protective device that has required a great deal of research work and experimenting by technical and skilled men to perfect it to the extent we find it today. In the factories great care must be given to the construction and the assembling of parts in order that the output will be uniform."

After reviewing the situation along these lines, Mr. McIntosh asks a very important question, viz: "Will the fuse, as a protective device, receive greater abuse under the proposed code amendment than at present?" From my point of view, this cannot be decided merely from field experience. Good, common sense must be used, and the question must be decided principally from a psychological point of view.

Mr. J. C. Kahl, in his article on the present fuse situation in the December edition of *Electrical Engineering,* concedes that over-fusing is a logical argument against the refillable fuse. "But," he says, "this is also an argument against the non-refillable type, for what is to prevent soldering a fuse wire across the shell of a non-refillable fuse to increase its capacity?" By allowing the use of the refillable type, the unscrupulous electrician is given a much easier method to do exactly what the underwriters are trying to guard against, and that is over-fusing. For it goes without saying that it is much easier to insert two or even three strips in a refillable cartridge than it is to solder a strip of metal across the shells of a non-refillable fuse. In the first case the danger is concealed; in the second it is easily seen.

In the large plants, the chief, on his tours of inspection, can easily detect metal soldered across fuse shells, but in the case of the refillable fuse he can only take the word of his men for the fuses being right. The best of us are not immune to such thoughtlessness as over-fusing a circuit "just temporarily," and we don't always remember that "temporarily" over-fused line. The writer has already seen cases of double strips in refillable fuses, in which one strip only was allowed. It is just these human weaknesses which ought to be guarded against. The old saying, "An ounce of prevention is worth a pound of cure," is worth adhering to. There are already too many accidents laid at the door of electricity. Mr. Kahl is perhaps perfectly reliable in handling his fuse problems, and if the underwriters had only men like Mr. Kahl to deal with, the proposition could easily be decided. But, unfortunately, this is not the case. In the electrical field, as in all other fields, we find all kinds of men. Can we jeopardize the safety of the good men by the concealed acts of the inefficient?

This is an age of specialists. Every department in the electrical industry has its expert specialists. It is an undisputed fact that every apparatus can be perfected to its highest state of efficiency only by specialists. Why shouldn't a fuse be as efficient in the performance of its duty as the motor it protects? In the majority of installations the fuse is the only protective device, and as such it is very important. Then why shouldn't the fuse problems be handled by those who have specialized in them? Let us hope that this question will be decided from an unbiased, common sense point of view, with the ideal of safety uppermost in our minds.

O. R. Blumberg, B. E. E. (Mich.)

Voltages Secured by Connecting Three-Phase Transformer for Operation as Auto-Transformer. Ans. Ques. No. 415.

Editor Electrical Engineering:

In working out the load voltages for the three different arrangements asked for in question 415, let it be assumed in each case that we have on the line side a balanced three-phase source of power with a voltage across each phase of E. Let it be assumed that the three-phase transformer is one in which a represents the number of turns on each of the three high tension windings, and b represents the turns on each of the low tension windings. Then the ratio of transformation of the transformer would be $a : b$. On the load side of the transformer let the voltage across each phase be represented by X.

Arrangement No. 1 can be drawn as shown in Fig. 1

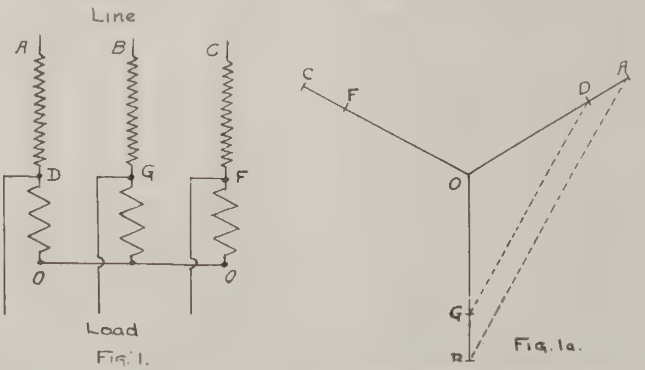


Fig. 1. Showing Y Auto-Transformer Connections.

This shows more clearly that it is a Y connection, each leg being formed by the primary and secondary of one phase connected in series. If now the primary potential E be applied, the voltages across the various windings can be represented by the lines in Fig. 1a, both in position and value. The line voltage E is represented by line AB, and load voltage X by line DG. The line DO represents the voltage across one of the high tension windings, and line AD represents the voltage across the corresponding low tension winding. The ratio of the length of OD to length AD is $a : b$ or the ratio of transformation is,

$$E : X = a + b : a$$

$X = Ea \div (a + b)$. If $E = 2200$ volts and $a : b = 10 : 1$, then $X = (2200 \times 10) \div 11 = 2000$ volts.

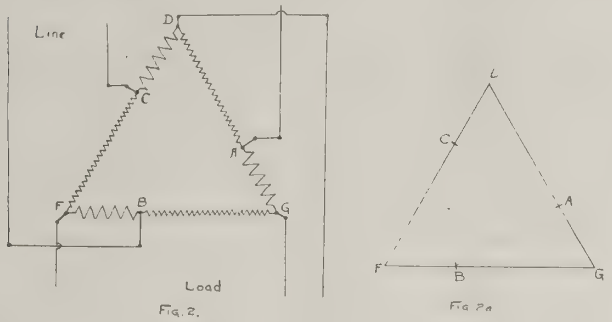


Fig. 2. Fig 2a

FIG. 2. SHOWING DELTA AUTO-TRANSFORMER CONNECTIONS.

For the second arrangement, Fig. 2 gives in effect the connections and shows that there is a delta connection of all the windings. As above, we can represent the various voltages both in value and position by a vector diagram. Line $A\ B$ represents E or line voltage, line $D\ G$ represents X or load voltage and the ratio of line $A\ G$ to line $D\ A$ is expressed by $a : b$.

$X = E\ (a + b) \div [\sqrt{(a^2 - a\,b + b^2)}]$. If, as above $E = 2200$ volts and $a : b = 10 : 1$, then,

$X = (2200 \times 11) \div [\sqrt{(100 - 10 + 1)}]$.

$X = 2537$ volts.

The third arrangement can be represented by Fig. 3 in a manner similar to Figs. 1 and 2. Points A, B and C are the three points of line connections and points D, F and G, the three points of load connections. In the diagram of

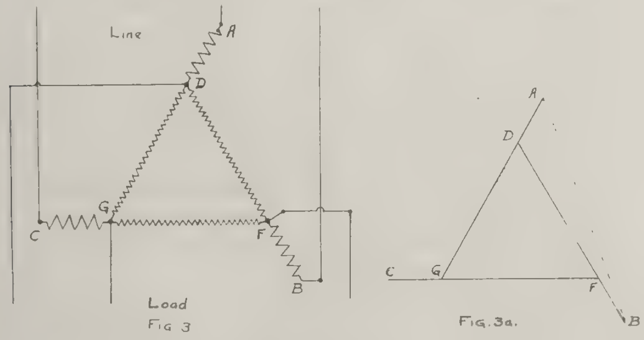


Fig 3 Fig. 3a.

FIG. 3. SHOWING COMBINED Y AND DELTA AUTO-TRANSFORMER CONNECTIONS.

voltages (Fig. 3a) AB represents E the line voltage and DF represents X the load voltage and the ratio $DG : AD = a : b$.

Then $X = E\ a \div [\sqrt{(a^2 + 3ab + 3b^2)}]$. If $E = 2200$ and $a : b = 10 : 1$, then,

$X = (10 \times 2200) \div [\sqrt{(100 + 30 + 3)}]$.

$X = 1907$ volts.

H. W. R. (Ga.)

Three-Phase Transformer Connections for Auto-Transformer Operation. Ans. Ques. No. 415.

Editor Electrical Engineering:

In answer to question 415 in the December issue of *Electrical Engineering,* the writer offers the following method for finding the voltages for the different combinations shown by L. C. J. in his question: In each of the cases the coils may be connected so that the voltage in each phase will be increased or decreased. In the first case the connection is a boosting one and in the second a bucking one. In Fig. 1 the vector diagrams for both connections are given, as the boosting and bucking relations of the coils are here clearly shown. In the other cases only the boosting connections are considered. It is to be observed in these connections, however, that when the coils are so connected that there is a boosting effect in each phase, the resulting load voltage is less than the line voltage. This is on account of the fact that the load and line connections must be interchanged to get an increase of voltage from these so-called boosting connections.

Case I. The connections shown in Fig. 1 are a star arrangement, and the load voltage is lower than the line voltage about in the proportion to the ratio of the transformers. For a 10 to 1 ratio the reduction is 9.1 per cent with coils boosting in each phase. When coils are bucking in each phase the load voltage is increased over the line voltage 6.35 per cent for a 10 to 1 ratio of transformers. This is calculated as follows: E = line voltage = $\sqrt{3}\ (Y + X)$ for boosting of coils and $\sqrt{3}\ (Y - X)$ for bucking of same. S = load voltage in each case. Then $E : S = (Y + X) : Y$ or $= (Y - X) : Y$, according to connections.

Case II. This set of connections is a delta arrangement, in which, as shown, the secondary coils result in a subtracting from or adding to the voltage of each primary phase. As in Case I, if X indicates secondary coils and Y indicates primary coils of the transformers, the volt-

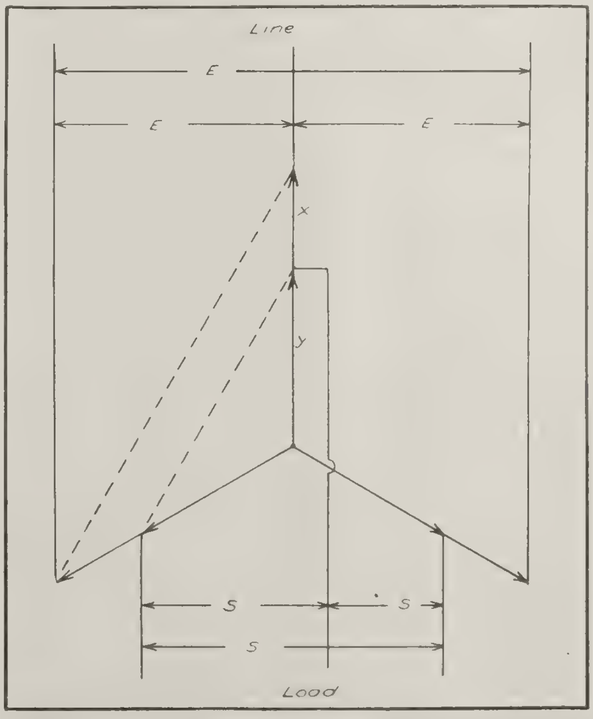


FIG. 1. STAR ARRANGEMENT OF AUTOTRANSFORMER CONNECTIONS.

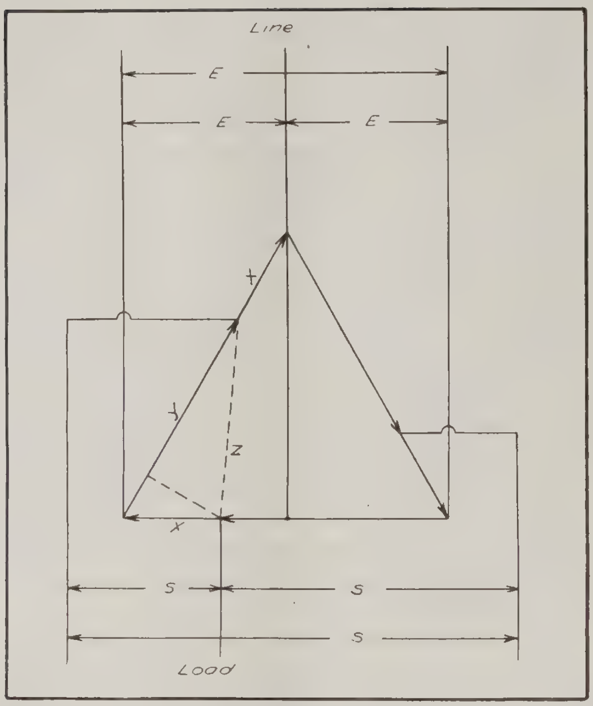


Fig. 2. Delta Arrangement of Autotransformer Connections.

ages can be found as follows: The case here considered is when the voltage of the secondary coils subtract from the voltage of the primary coils. E is the line voltage and S the load voltage. Then $(Y - X \cos 60^\circ)^2 + (X \cos 30^\circ)^2 = S^2$.

$Y^2 - XY + X^2/4 + .75\ X^2 = S^2$.

$\sqrt{(Y^2 - X\,Y + X^2)} = S$ and $E = X + Y$.

$(E - S) \div E = 13.3\%$ decrease of line voltage.

Case III. The connections shown in Fig. 3 are for a delta arrangement, and, like the connections in Case II, the secondary coils may subtract from or add to the voltage of each primary phase. The value of load voltage with 10 to 1 ratio transformers is determined as follows when the secondary coils boost the voltage in each phase. Referring to Fig. 3:

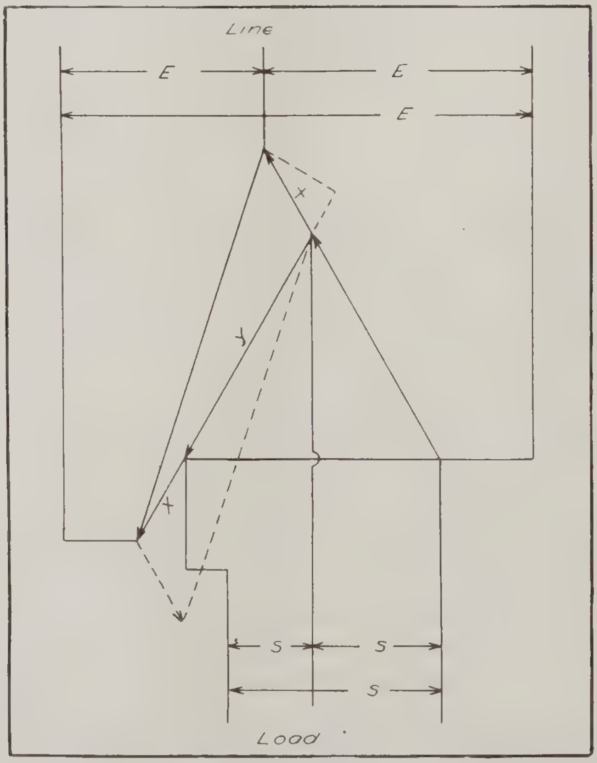


Fig. 3. Delta-Star Arrangement of Autotransformer Connections.

$(X + Y + X \cos 60^\circ)^2 + (X \cos 30^\circ)^2 = E^2$.

$9\,X^2/4 + 3XY + Y^2 + .75\ X^2 = E^2$.

$\sqrt{(3\ X^2 + 3\ X\ Y + Y^2)} = E$. Here $S = Y$.

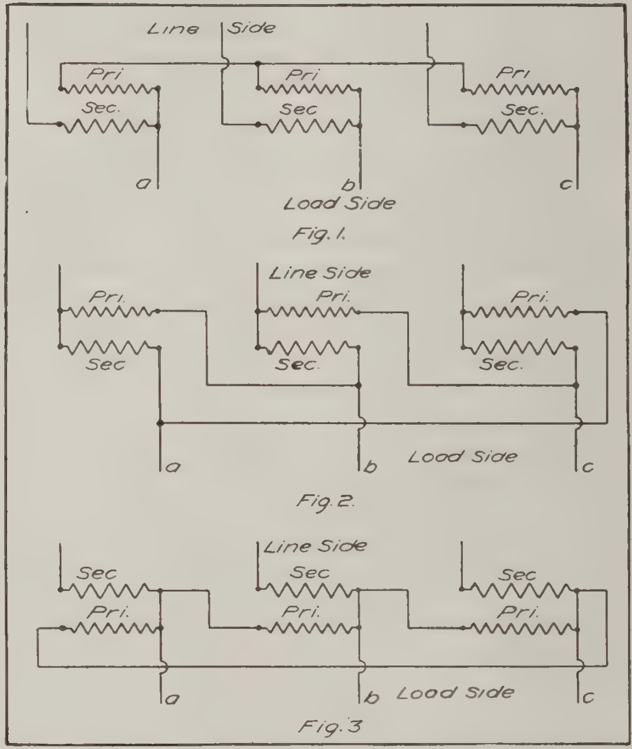
$(E - S) \div E = 13.2\%$ decrease of the line voltage.

H. L. Williams (Ga.).

Voltages Secured From 3-Phase Transformers for Auto-Transformer Operation. Ans. Ques. No. 415.

Editor Electrical Engineering:

With transformer primaries Y connected ahead of the secondaries, the boost per phase will be practically the ratio of the transformers. That is, for a ratio of 10 to 1 the boost will be 10 per cent; for 20 to 1 ratio, 5 per cent of the line voltage, etc. This increase of voltage will be added to the line voltage. This applies to Fig. 1 as shown by L. C. J. in the December issue.



Figs. 1, 2, and 3. Connection of 3-Phase Transformers for Auto-Transformer Operation Given by L. C. J.

With delta connected primaries ahead of the secondaries, the bucking effect will be about 15 per cent for a 10 to 1 ratio and 7.5 per cent for a 20 to 1 ratio. With delta connection of primaries behind the secondaries, the buck will be about 14.7 per cent for a 10 to 1 ratio and 7 per cent for a 20 to 1 ratio. This is for the case shown in Fig 3 by L. C. J.

L. M. Klinefelter (Colo.).

Rate for Selling Live Steam. Ans. Ques. No. 420.

Editor Electrical Engineering:

In answer to Question No. 420 in the December issue of *Electrical Engineering* asking for a method of calculating the rate for the sale of live steam, the writer desires to say that in his opinion the best rate is one based on a thousand pounds of steam used. This quantity may be determined in several ways. The condensation can be collected in a trap made to empty into a tank meter. Another and better way is to install a steam flow meter in the supply line to read the flow in a convenient unit such as pounds of steam per hour.

The calculation of a rate for the sale of steam is an interesting engineering problem on account of the varying conditions and one on which there are various opinions. In the main the conditions involved are, steam used per hour, price paid for coal, wages of fireman and the cost of other labor if the selling of the steam requires such. To illustrate the calculation, we will assume a case where 1,000 lbs. of steam is used per hour or 33.33 Hp, from a plant where 8 lbs of water is evaporated per pound of coal. In such a case it will take 3.75 lbs. of coal per Hp or 125 lbs. to produce 1,000 lbs. of steam. With coal at $2.00 per ton of 2,000 lbs., the cost of 125 lbs. of coal is 12.5 cents. It will take 120 gallons of water to produce this steam but unless the water rate is high, it will not be necessary to figure on this cost. Assume the rate paid for fireman at 30 cents per hour. This makes the total cost of 1,000 lbs. of steam 42.5 cents. It will be noted that if only one fireman is employed all this time cannot be charged against the steam sold but only a part of same. For instance, if 6,000 lbs. of steam per hour were generated only 5 cents is chargeable to the 1,000 pounds of steam sold, which would make the total cost of the steam 17.5 cents instead of 42.5 cents. Whatever this rate may be, there should be added about 14 per cent for interest on investment, taxes, depreciation and insurance.

At the writer's plant, where coal costs about $2.00 per ton, the rate charged for live steam is 40 cents per thousand pounds of steam used. The wages paid for fireman ranges from 20 to 25 cents per hour. The water rate is 12 cents per 1,000 gallons. The indicating and recording meter is found most satisfactory since it presents a record of the amount of steam used per day, which records may be preserved and at the end of the month all that is required is to total the amount of steam used and prepare bill for same. A. L. Oesteslo (Ohio).

Rate for Selling Live Steam. Ans. Ques. No. 420.

Editor Electrical Engineering:

The sale of steam for use at points more or less distant from the plant in which it is generated is found profitable if the system of transmission be properly designed. There are many central generating plants, notably in New York City, which make a specialty of selling steam for heating and power purposes, the experience of which make definite predictions of results possible. With the proper layout of the piping system, choice of economic size of pipe, sufficient provision for insulation to guard against heat loss by radiation, the plan of the inquirer should work out with success.

Exhaust steam from the engines of a power plant is usually employed in long distance heating and if exhaust steam fulfills the requirements of the customer, its use is more economical and hence more profitable than the use of live steam since the exhaust which ordinarily might be wasted may thus be turned into account. If live steam is necessary in the problem at hand it should first be determined whether the boiler capacity of the generating plant is sufficient to provide steam for the use of the plant as well as for the needs of the laundry. Since data regarding the boiler of the power plant are not available nothing regarding this phase of the problem can be taken up here.

The basis from which the rate to be charged for the delivered steam may be calculated depends upon (a) the cost of installation of the piping system, (b) cost of generating steam, (c) maintenance of the system and (d) the amount of profit to be obtained. Under (a) a very important item is the size of pipe to be used. Four factors must be considered here; the friction of the steam in the pipe, resulting in loss of pressure; the area of the pipe itself, resulting in loss of heat by radiation; the cost of labor for the installation. In a small pipe the friction is large resulting in great loss of pressure. As the size of pipe increases, friction decreases rapidly, but at the same time as the area of the pipe increases, the radiation surface becomes rapidly greater and also the cost of the pipe increases. The labor charge will be about the same irrespective of the size of pipe. It therefore becomes necessary to choose a pipe of such diameter that the losses through both friction and radiation may be a minimum and that the cost of the pipe may be as low as possible compatible with the above requirements. Since data regarding boiler capacity, cost of material, labor and nature of ground between plant and laundry (that is, whether pavements will have to be torn up and permits obtained and charges for latter, if any) etc., are not at hand, no calculations will be included herein, but, as to the size of pipe, it may be estimated that a 3 or 3½-inch pipe will be the economical size. The other items under cost of installation will depend upon local conditions. Cost under (b) will depend upon the cost of coal, which is given and the efficiency of the boilers and their operation, which is not given and which will have to be determined from records of the plant. Item (c) should be small if the piping is properly installed and ample insulation is provided. Profit (d) will be determined by the plant owner and all these items, with a charge for depreciation, which should be small in an installation of this kind, will have to be considered to fix a rate satisfactorily. As to measuring steam sold, there are a number of steam flow meters on the market from which can be chosen the one best suited to the needs of this problem.

If a precise solution of the problem is desired instead of a hit or miss method of calculation, the advice of a competent engineer should be secured so that all the factors regarding the situation can be considered on the ground and definite results assured. Louis D. Webster. (Ill.)

Rate for Selling Live Steam. Ans. Ques. No. 420.

Editor Electrical Engineering:

In reply to Question No. 420 in the December issue, the writer will say that he once had occasion to investigate the matter of measuring steam for laundries and other steam consumers; such as heating plants, etc. The only satisfactory method, deduced from the investigation was to install steam meters. In cases where all the steam was condensed and the condensation available for measurement, tilting traps with counters for registering the number of discharges of the trap were utilized satisfactorily.

Laundries, however, use a good deal of steam in washing machines, soap-making, and other ways wherein it is not possible to trap the condensation for measurement. For such establishments, therefore, the steam meter affords the only feasible means of measuring the steam. This gives a pretty accurate account of the steam passing through it and, while apparently rather expensive, yet this feature is more than offset by the satisfaction derived from the knowledge that all concerned are getting a square deal. All other methods were found to be nothing more than the crudest of guesses and, in the intrinsic nature of things, could scarcely be expected to yield anything but eventual dissatisfaction.

To establish an equitable rate for the sale of steam, it will, of course, be necessary to calculate the cost of its generation. This will include the following factors: Interest on the cost of the plant,—not the engines, but merely the boiler room and its equipment; depreciation; taxes; labor; repairs and maintenance expense; fuel; and water. The cost of a 300 Kw. boiler room, complete, would probably not be far from $25,000. At six per cent, the interest charge would amount to $1,500 a year. The depreciation might be taken at 5 per cent, as twenty years is a tolerably long life for a boiler plant. For this item then there would have to be $1,250 set aside each year. Taxes might come to say 15 mills on the dollar, making $375 per year for that much deplored expense. Labor varies wth the different localities, but a fair calculation for a plant of this capacity would be, say, three firemen, one for each eight hour shift, and three boiler room helpers, for coal passing, ash wheeling, boiler washing, etc. Six men in all, at $2.50 each per day, totalling an outlay of $5,475 labor expense for the year.

In the plant referred to at the beginning, which was of about 500 boiler horsepower capacity, the repair and supply expense for the boiler room alone averaged around $650 yearly. This included such things as brooms, shovels, packing, soap, lye, metal polish, and, in fact, all that pertains to the cleanliness and upkeep of the plant.

Fuel and water expense will vary with the load on the plant and the local price. In the plant mentioned, oil fuel was used, costing 75 cents per barrel of 42 gallons. This was figured as being equivalent, when burned under the boilers, to coal at $2.20 per ton. A price approximately the same as that stated by W. A. T., since it will doubtless cost him the extra 20 cents per ton by the time the coal is delivered in his boiler room. We burned about 12,000 barrels, or $9,000 worth of the oil per year. The water bill came to $89.10, average per year, being the cost of 324,0000 gallons at 27½ cents per thousand gallons.

The total plant expense then for one year sums up as follows:

Interest	$ 1,500.00
Depreciation	1,250.00
Taxes	375.00
Labor	5,475.00
Repairs and Supplies	650.00
Fuel Oil	9,000.00
Water	89.10
Total Expense	$18,339.10

If we have now the total amount of steam generated, the cost per unit of steam is readily calculated. The total evaporation of the boilers may be found by installing a Venturi or General Electric boiler feed water meter, or other device. Any plant aspiring to anything like pretensions of fuel economy and good business methods cannot afford to be without a device of this sort. It proves a reliable check on the cost of generating steam from day to day, and should be installed in the plant as a part of its equipment just as essential as a feedwater heater, flue blower, or any other device of an economical sort.

In our case, the feed water meter, a Venturi, showed, in round numbers, a yearly evaporation of 56,000,000 pounds of water. Dividing the total expense as figured above, $18,339.10 by this quantity, it is found that the steam cost us nearly 33 cents per thousand pounds generated.

The laundry consumption was, say, 5,000,000 pounds panse of generating the steam was .33 × 5,000 = $1,650 per year, by the meter. Then, its share of the total exper annum.

V. C. Vance. (Cal.)

Changing 220 Volt A. C. Motor to 110 Volt. Ans. Ques. No. 419.

Editor Electrical Engineering:

Not all 220 volt A. C. motors can be changed to 110 volts. If the serial number of the motor is available, the manufacturers will, on request, furnish diagram of connections if the desired connection is feasible. If no information is available, anyone who understands motor windings can reconnect the coils without a diagram. Where you now have two groups of coils in series, on 220 volts, place them in parallel on 110. If the 220 volt motor is connected in "Y," a fairly satisfactory 110 volt motor may be made out of it by connecting it in delta.

Why Series Transformers on Open Circuit Burns Up. Ans. Ques. No. 424.

The additional heating of the series transformer when the secondary is open-circuited is caused by the increased core loss. With the secondary short-circuited, the secondary ampere turns are practically equal and opposite to the primary ampere turns, so that the magneto-motive force acting on the iron circuit is very low. This results in a low flux density and low core loss. When the secondary is open-circuited, the primary turns all become magnetizing turns, so that the iron may be worked at a very high flux density, and the core loss would be excessive. The heating would not be noticeable unless the line on which the transformer is used is loaded at the time the secondary is opened.

Rewinding Small Motors. Ans. Ques. No. 425.

In order to make exact calculations, it would be necessary to know the dimensions of the motor, such as length of airgap, area of pole face, and desired speed, etc. The specifications as given below will be satisfactory for the ordinary size of battery motor. It is doubtful whether the motor would run satisfactorily, as the small number of commutator segments, high voltage between bars, and large number of turns per coil would make commutation very poor.

For the shunt field use about 6,000 turns of No. 34 D. C. C. copper wire. For the armature, wind 200 turns of No. 26 D. C. C. wire in slots 1 and 4, 2 and 5, 3 and 6. Calling these coils No. 1, No. 2 and No. 3, connect the ends of coil No. 1 to commutator segments 1 and 2; connect the ends of coil No. 2 to segments 2 and 3, and the ends of coil No. 3 to segments 3 and 1. The motor so wound will run at about 1,200 R. P. M. Prof. F. T. Rankin. (Colo.)

Coughing in a Storage Battery Room. Ans. Ques. No. 422.

Editor Electrical Engineering:

In reference to the answers to the question, "Coughing in a Storage Battery Room," in the January issue of *Electrical Engineering*, I take the liberty to offer the following remarks without taking the advantage of advertising any make of storage cell.

The writer has had thirty-four years practical experience in construction and maintenance of storage batteries, having been with the E. P. S. Co. and can with confidence state, that the only men I know of connected with battery work who are in any way effected are those who are employed in the pasting department. These men in many cases suffer from lead poison. The tiny balloons which we are informed float and finally strike against an object and burst, scare me, for should this be the case the writer must be full of bursted minature balloons, as I have made it a practice to lean over the opening of a storage cell and deliberately inhale the fumes first thing in the morning, thinking it was beneficial.

Fumes from a storage battery would not, in my opinion, cause tuberculosis, but persons suffering from tuberculosis would certainly cough by inhaling fumes of any kind from a storage battery. Hy Albert. (N. C.)

Distribution of Light From Ornamental White Way Post. Ans. Ques. No. 423.

Editor Electrical Engineering:

The writer knows of no distribution curves which have been run on complete white way units of the size mentioned in question 423. A study of the distribution curve, Fig. 1, of a 100-watt tungsten unit with an opalescent ball, shows that for the zone between 45 and 90 degrees the candle power is a maximum and nearly constant throughout this zone. The curve of the complete unit will approximate closely this curve of the single unit, except that the candle power values will be nearly five times as great. Of course, in four directions from the complete unit, the light from one of them will be partially cut off by the post; this amount, however, is not very great. The fact that the center ball is inverted will have the effect of slightly increasing the candle power in the zone between 90 and 135 degrees. The arrangement of the group and the question of upright and pendant position has, however, less bearing on the total distribution than the character of glass used. The curve shown is for a fairly dense opal glass. A less diffusing unit would have higher candle power values at angles near the horizontal, and lower downward intensity.

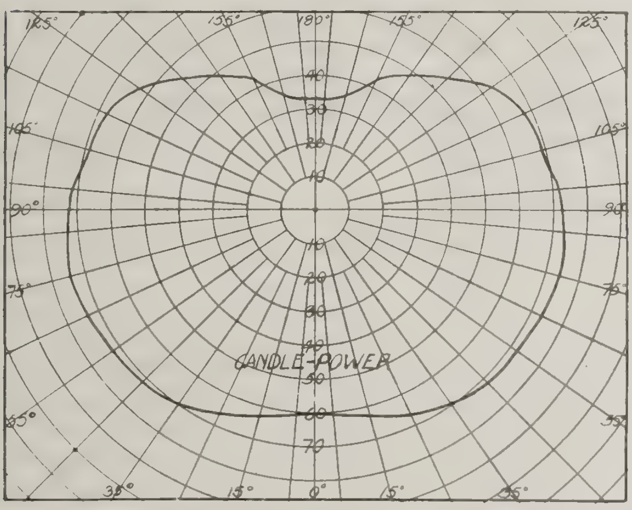


Fig. 1. Distribution Curve of a 100-Watt Tungsten Street Llghting Unit, Equipped with a 12-Inch Opalescent Globe.

Evan J. Edwards (Ohio).

Engineering Department, National Lamp Works of G. E. Co.

Reversing Field of D. C. Exciter. Ans. Ques. No. 430.

Editor Electrical Engineering:

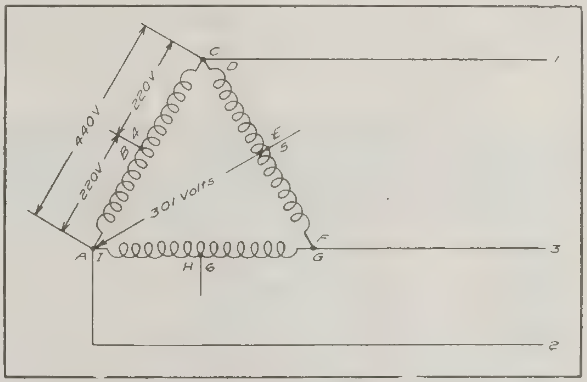
The following is in answer to question 430, appearing in the January issue: Outside of a burn-out or some such sudden trouble to the exciters, the most probable reason for the reversal of the field of one of them is that the line was opened while the machine was under load. The current through the coils would thus be broken suddenly, and a heavy kick of self-induction would follow, which would tend to demagnetize the field, or even magnetize it in the reverse direction.

The easiest way to remagnetize this field is as follows: Open-circuit the armature of the faulty generator either by opening the line or by raising the brushes from the commutator. Connect the leads of the shunt coil to the main circuit of the other exciter, which has been previously disconnected from the alternators. Now run the good exciter slowly, and current from it will flow through the shunt coil of the faulty exciter, magnetizing the field in the proper direction. The equalizer connection should be disconnected. V. A. Clarke (Ohio).

Connections for Motors to Delta Connected Transformers. Ans. Ques. No. 431.

Editor Electrical Engineering:

Replying to T. C. M.'s question regarding voltages at middle taps of secondary windings, will say that this can be explained very easily by drawing the graphic diagram of the delta connection. By comparison, the diagram shown here will be found similar to figure submitted by T. C. M.



Connections for 220 and 440-Volt Motors to Delta Transformers.

Consider voltage between 5 and 6. It is the same as between E-F or G-H, that is, 220 volts. T. C. M. says his 220-volt motor runs alright on leads A, 4 and 5. Theoretically the voltage between A and 5 is 381. The writer would like to know what the voltmeter actually shows between these leads.

It is the writer's opinion that the motor should be connected to leads 4, 5 and 6 and when so connected the load will be balanced better between the transformers.

J. A. Collat. (Ga.)

Cross Currents Between Y Wound Alternators in Parallel. Ans. Ques. No. 436.

Editor Electrical Engineering:

The following is a reply to question No. 436, in the February issue of *Electrical Engineering:* Dr. C. P. Steinmetz, in *"Elements of Electrical Engineering,"* on page 159, discusses the circulating currents between Y connected generators in parallel with their neutrals solidly tied together. The reason for not solidly tying the neutral points of Y connected A. C. generators together when operating in parallel is danger of circulation currents from the third harmonic, which will cause a current of three times normal frequency of the generators to flow over the neutral and circulate in the generator windings, causing heating. It is, therefore, undesirable to ground or connect together the neutrals of three-phase generators without a resistance, but in case it is desired to ground neutrals, either the neutral should be connected to separate resistances of proper values for each machine, or grounded only in one machine, the neutrals of the remaining machines being left disconnected.

The resistances used for grounding large generators must be designed to dissipate large amounts of energy for a short period of time; and on high voltage generators the problems of insulation, together with the large amount of material required, make the cost of the resistances high. It should be borne in mind that the third harmonic only appears between the neutral and the outside lines, but does not appear across the phases; and also in machines of the same wave shape, a flow of current will take place across the neutral only on account of phase differences of generators operating in parallel, due to differences in field excitation.

The answer to your correspondent's second question is contained in the answer to the first.

The third question may be answered in the affirmative—that there is a possibility of cross currents existing in the windings of two or more banks of transformers Y connected with the neutrals directly connected together and the entire installation grounded from a ground bus through one resistance. However, the probability is very remote that any trouble would ever be experienced, for the following reasons: As has been pointed out in the answer to the first question, although triple frequency exists in the Y connected generator windings, the triple frequency cancels out in the delta voltages and is not transmitted on the line. Transformer primaries, however, connected in Y will show the presence of triple frequency between the neutral and lines, the magnitude of the triple frequency voltages depending, to a large extent, on the design of the transformers. A rather clear view of this may be secured from Franklin's *Electric Waves,* chapter 9. Owing to the fact that the triple frequency in similar design of transformers would be always of practically the same amplitude and in phase, there would be no flow of current to the neutrals connected together from this source. In widely dissimilar designs of transformers operating in parallel with their neutrals connected together then, it might be possible for an appreciable flow of current to take place, owing to the phase difference of the triple frequency and possible differences in magnitudes of the triple frequency voltage waves. It is quite probable, however, that transformers having dissimilar enough characteristics to produce any decided triple frequency circulation current would be of such characteristics that they would not operate satisfactorily in parallel from other causes. It might be well to state at this point that transformers of different ratings, and particularly transformers made by different manufacturers, should not be connected in parallel without having first taken the matter up with the manufacturers, as serious trouble is likely to result if transformers are not designed to operate in parallel with each other.

H. E. Bussey (Ga.).

New Apparatus and Appliances

Paiste Separable Attachment Plug.

A new separable attachment plug has been produced by the H. T. Paiste Company of Philadelphia, Pa., in which neatness and small size are special features. As shown in the illustration, a fiber washer slips down the shaft and fits into a shoulder in the edge of the cap and hides the ragged wire ends as well as prevents the collection of dirt. When wiring this plug, the washer is slipped off, leaving the contact screws exposed and easy to wire. A strain relief makes an Underwriters' knot unnecessary. Strength in the shaft is secured by the heavy brass contact bars which are molded into the cap. A firm grip and good contact are secured by using folded bronze springs in the base and nibs on these springs catch on recesses in the brass bars of the cap. A complete line of brass flush receptacles, pipe taplet receptacles, current taps, chandelier receptacles, porcelain conduit box and wall receptacles are manufactured to take this plug.

FIGS. 1 AND 2. THE COMPLETE PAISTE PLUG AND VIEW OF SAME WITH WASHER RAISED FOR WIRING.

Ralco Twin Receptacle.

A twin receptacle with housing, as shown in the accompanying illustration, has been placed on the market by the Central Electric Company, 320-26 South Fifth avenue, Chicago, Ill. Two designs are made available, known as No. 15 and 16, in both fused and fuseless types. The former consists of two 30 ampere receptacles fitted into a cast iron box 6 by 8 inches by 2¼ inches deep. In the design of the box special attention was given to the ease with which it could be wired, and, to assist the electrician, ample space was provided for that purpose. The box is primarily designed for inside use, and is fitted with ¾-inch knockout on two sides and top. When the receptable is required for outside use, it can be made waterproof. Type No. 16 is identical in construction to the No. 15, except that the box is 9¼ by 8 inches by 2¼ inches deep, with space on top for either one or two D. & W. cutouts. When equipped with one cutout, the boxes are marked 15 amperes per plug, and when equipped with two cutouts, 30 amperes per plug, because the fuse block governs the rating. Although shown in cut with one cutout, unless otherwise specified on order, the No. 16 will be furnished with two cutouts, and marked 30 amperes per plug.

Fuse blocks and receptacles come wired, so that all that is necessary in order to install it is to bring the line wires down to the terminals of the fuse block. A door is provided in front in order to make it easy to remove a fuse when blown. The receptacles are useful around machine shops where two portable light outlets or portable motor outlets are required.

THE RALCO TWIN RECEPTACLE.

A Good Record of Cable Life and Condition.

On account of the fact that the United States government has decided to dredge a channel into Jamaica Bay, the Commercial Cable Company was notified to remove its cables crossing the line of proposed operations. The cable company has therefore removed its cables and makes the following report of their condition:

"All of the cables which we have thus far withdrawn (about 18 miles in length) have proved to be in excellent condition, so much so that we are relaying them between New York and Far Rockaway and, judging from their condition, have every reason to hope that they will still last many years, as from their appearance the time elapsed since they were laid does not seem to have affected the insulation at all."

These cables were manufactured and installed in underground conduits by The Okonite Company, 253 Broadway, New York City, in 1900 and 1904 to connect the Trans-Atlantic and other deep sea cables of the Commercial Cable Company, the route being from their main office in New York City to a point on the seashore of the eastern end of Coney Island.

The change of cable route by the cable company and transferring of its landing place from Coney Island to Far Rockaway, which is well outside of the zone of dredging operations necessitated the laying of an underground connection from the main office in New York City to Far Rockaway, a distance of 22 miles. The contract for the making of this connection was awarded to The Okonite Company and consisted of three 14-conductor lead covered cables installed in underground conduits which, when the installation was complete, tested up to the usual standard and well in excess of the specifications, which were most exacting.

The transfer of the ocean cables and the connection with the office having been accomplished, there was no further use for the cables over the Coney Island route, so it was decided to take them out of the conduits and relay them as extra conductors over the Far Rockaway line. This work is now in progress and as the sections are relaid and connected up, tests show the electrical and physical condition of the conductors to be practically unimpaired after fourteen and ten years of uninterrupted service, a very good record for cable performance under such conditions.

A Large Lighting Fixture.

A large lighting fixture of interesting design has recently been installed in the department store of Cohen Brothers, at Jacksonville, Florida. The store occupies a city block and its design is unique in that the center of the entire building is open from the first floor to a large dome in the roof, four stories above. The fixture, shown in Fig. 1, is hung from the dome by heavy ornamental chains, its lowest point being well above the level of the second floor. The fixture is made of cast bronze with the natural bright finish which adds to the value of the surface as a reflector, although the fixture is not designed primarily to reflect a very large part of the light which strikes it. Its overall length is 19 feet 8 inches and its extreme width 10 feet 6 inches. It is very heavy, weighing 4,100 pounds, the greater part of it being made up of solid castings.

The electrical equipment consists of 216 25-watt tungsten lamps arranged in seven tiers, six on the lower or main part of the fixture and one tier on that part above the chain supports. These seven tiers are wired in 14 circuits which permits a very flexible use of the unit, since nearly any desired intensity of light may be obtained by switching on the required number of lamps. A 250-watt clear lamp enclosed in an opal glass ball and placed at the base of the unit completes the lamp equipment.

LARGE FIXTURE INSTALLED AT JACKSONVILLE, FLA.

The fixture is designed more for effect than for efficient light utilization, although it brilliantly illuminates those sections of the store adjacent to it. As the illustration shows, the surfaces of the walls and the under surface of the dome are finished in white, which greatly increases the efficiency of the installation, since the greater portion of the light striking these surfaces is reflected to places where it is more useful. This fixture is said to be one of the largest single fixtures in the country. The complete unit was installed by the Jacksonville agents of the Fostoria Incandescent Lamp Division, National Lamp Works of General Electric Co.

Simplex Foot Warmer Rug.

The Simplex Electric Heating Company, of Cambridge, Mass., has produced an electric heating rug in the shape of a Wilton carpet rug, 15 by 27 inches, provided with two feet of cord, a plug and receptacle. The current consumption of the heating element is 100 watts, which at average lighting rates costs about one cent an hour to operate. It is designed for connection to a lighting socket and provides a suitable temperature for warming the feet. It is substantially constructed and may be walked on indefinitely without chance of injury, as the heater will outwear the carpet. It obviously has application anywhere where one may sit with a possibility of cold feet—in the home, office, on board ship, in an electric automobile, or wherever there is electric current available. It is furnished in gray, dull figured carpet, or can be supplied to order in any standard carpet colors.

A New Form of Voltmeter.

In the testing of insulated wires and cables designed for a great variety of purposes, a voltmeter, as we have known it heretofore, often fails to measure adequately the stresses to which the dielectric is subjected. Based on the integration of the sine wave, on the square root of the mean square of instantaneous values, voltmeter readings give little or no indication of unusual peaks in the voltage wave or of surges in the circuit. The need of an instrument which would give such readings arose in connection with the high voltage testing of wires and cables, it being well known that in such tests the peak of the wave is what counts in breaking down the insulation. In cable testing there is a considerable charging current, due to the electrostatic capacity of the cable,, and as this current is likely to distort the wave form, the ordinary voltmeter may give no definite information as to peak voltage.

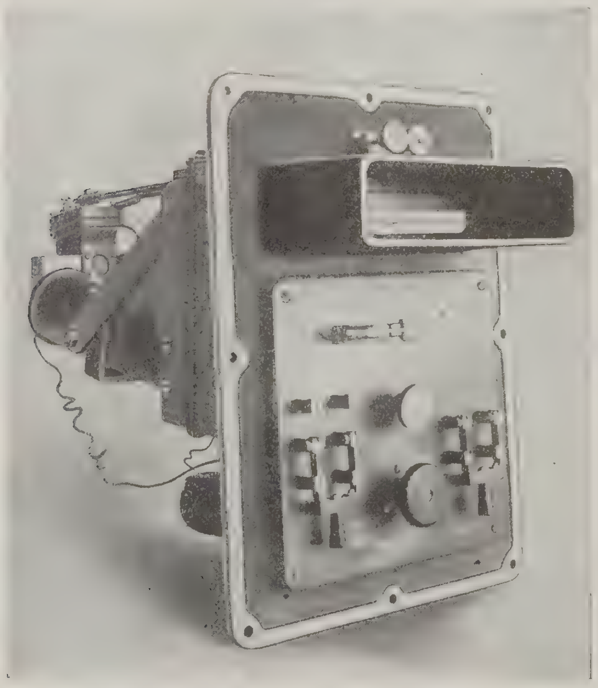


Fig. 1. Front View of Voltmeter.

After trying and discarding both a spark gap, which proved to be too easily affected by outside conditions, and an oscillograph, which is too delicate an instrument for factory use, the engineers of the Simplex Wire & Cable Company, Boston, have developed a peak voltage meter based upon the principle of the oscillograph, but with its movements confined to a straight line. This new instrument, illustrated herewith, indicates the peak of the voltage wave at the limit of oscillation along that line. It does not show the character of the wave or the form of its peak, but gives clearly the reading for that peak, whatever the shape of the wave may be.

The voltmeter of the switchboard type measures about 10 by 12 inches on the front and 14 inches deep. It consists essentially of a heavy electro magnet, between the poles of which is located the vibrator. By a suitable arrangement of lamp, mirror and lenses, a beam of light is thrown on a ground glass scale in front, graduated in volts. It is connected, through a potential transformer, directly on the high voltage circuit, the current being so small that the apparatus can be left in the circuit all the time. It can be quickly calibrated at any time by applying direct current of known voltage. While the meter has been developed to meet a particular factory, it will prove of considerable value in other lines as well as that of the manufacture of insulated wires and cables. A brief account of the development of this instrument appeared in the December, 1913, issue of *Electrical Engineering.*

Electrical Construction News

This department is maintained for the contractor, dealer, manufacturer and consulting engineer.

ALABAMA.

BIRMINGHAM. It is understood that the Birmingham Railway, Light & Power Company plans to spend one million and a quarter dollars for improvements to the electric, gas and railway departments. Of this amount approximately $170,000 will be spent for electric improvements. The engineers are Ford, Bacon & Davis, New York City.

FLORIDA.

MELBOURNE. The city has voted $5,000 in bonds to construct an electric light plant.

OCALA. The city plans to construct a power station to operate in connection with the water works and install two 250 Kw. generators, water tube boilers, switchboard equipments and auxiliary apparatus. J. B. Caldwalder is superintendent.

GEORGIA.

EASTMAN—The Eastman Light & Ice Company is to install electrical equipment. W. E. Davison is manager.

EATONTON. The Putnan Mills & Power Company is planning to construct a concrete dam on the Little River, near the site of its present dam.

VALDOSTA. It is understood that the Lowndes County Development Co. is to build a hydro-electric plant some ten miles west of Valdosta of a capacity of 3,000 Hp. Gordon J. Kilman, of Wigham, Ga., is engineer.

KENTUCKY.

BOWLING GREEN. The city plans to enlarge its electric light plant and install an ornamental street lighting system.

CENTRAL CITY. The Central City, Greensville, and Drakesboro Traction Co., is planning to construct a central steam-driven electric plant on the Green River two miles from Central City. Power will be transmitted to 21 coal mines from Central 200-mile radius. The cost of electric plant and transmission system will be about $3.000,000, and construction will begin about May 1st. The Central City, Greenville and Drakesboro Traction Co. is incorporated by S. J. Gish and James Small, of Central City; T. C. DuPont and Daniel Grauffield, of Wilmington, Del.; Hubert Meredith, Greenville, Ky.; L. L. Durham, New York City, and W H. Netherland, Louisville.

HOPKINSVILLE. The Pembroke Power Company is planning to construct ten miles of high tension transmission lines at a cost of $14,000. This line will connect the towns of Caskey, Saluvia Springs, Pembroke and Trenton, Kentucky. S. G. Ragsdale, of Pembroke, Ky., is general manager.

JEFFERSONTOWN. The city is to construct a street lighting system in the early future. G. A. Floore is chairman of trustees.

JENKINS. It is understood that the Consolidated Coal Co., of Fairmont, W. Va., is to construct 150 miles of transmission line to furnish electric light and power for mills and small towns. The power plant at Jenkins will be increased from 5,000 Kw. to 10,000 Kw. G. A. Maurer, of Jenkins, is constructing engineer.

LOUISVILLE. The Standard Lighting & Heating Company has been incorporated by T. C. Banton, T. H. Frinkin and Geo. B DeVol.

PRINCETON. It is understood that the Princeton Light & Power Company is to purchase a 150 Hp. boiler and a 100 Kw. three-phase, 60 cycle, 2200-volt generator. W. J. Holman is manager.

LOUISIANA.

BOGALUSA. The Great Southern Lumber Company plans to increase its lighting facilities.

ASHEVILLE. The Toxaway Power Company has been reorganized with a capital of $1,500,000 by W. B. Moore and H. S. Mitchell, of Pittsburgh, and G. H. Wright, of Asheville. It is understood that this company proposes to build a water power plant near Toxaway.

CONNELLY SPRINGS. The Connelly Springs Knitting Co. is to build a hydro-electric plant on the South Fork River to cost about $6,000.

ROANOKE RAPIDS. The Roanoke Rapids Power Company is contemplating the installation of an electric lighting plant.

SPANSVILLE. A report states that the Southern Power Company, of Charlotte, N. C., has contracted with the Hardaway Construction Company, of Columbus, Ga., to construct a power house and dam at Lookout Shoals on the Catawba River, of a capacity to develop 26,400 Hp. It is understood that four 6,600 Hp. units will be installed and that the plant will be complete by October 1st, 1914.

WENDELL. Bonds have been voted to the extent of $15,000 for the installation of a municipal electric lighting plant. It is understood that hydro-electric development is to be constructed and energy transmitted four miles.

WILMINGTON. The Tide Water Power Company, of Wilmington, is to purchase a 500Kw. rotary converter with switchboard and install a complete street lighting system in the early future. Raymond Hunt is Superintendent.

TENNESSEE.

CHATTANOOGA. The Tennessee Valley Light & Power Company has been organized with a capital stock of $1,100,000. W. Emery Wardwell is secretary, of Providence, R. I.

GORDONSVILLE. The Gordonsville Electric Light & Power Co., is to construct a plant of small capacity and build a transmission line. S. A. Smith is manager.

JACKSON. The Jackson Railway & Light Co., will increase its capital stock from $600,000 to $700,000.

NASHVILLE. Reports state that the Nashville Traction Co., proposes to build a new street railway system in Nashville. The construction of a power plant in the Green River Coal fields is also planned. In addition the proposition of taking over the Municipal Light & Power Plant in the event the city contracts with the Tennessee Power Co., for hydro-electric power.

SOUTH PITTSBURGH. The South Pittsburgh Electric Light & Power Co. has completed arrangements for the erection of a transmission line from the hyro-electric power plant at Hales Bar, Tenn. This company will furnish electricity to Jasper, Withwell, Bridgeport and other Tennessee towns.

SOUTH CAROLINA.

WALHALLA. The Walhalla Light & Power Company has plans for a concrete dam and four miles of transmission system to furnish light and power to Walhalla, West Union and Seneca. J. I. Linler, of Walhalla, is engineer.

WEST UNION. It is understood that a hydro-electric plant is to be constructed at Rhett Shoals on Big Cane Creek, two miles below West Union. W. A. Strothers and J. W. Bell, of Walhalla, are interested.

TEXAS.

FREEPORT. In connection with the new superheated water and power plant now being installed at the Freeport Sulphur Company's mines at Bryan Heights, a new central electric power plant has been recently included in the plans, and will be installed in the next few months. This plant, through transmission lines, it is announced by the company, will supply electric light and power to Freeport. This central power station will be of proportions to do all the work at the mines at Bryan Heights, where electric power can be used, such as operating electrically driven pumps, to pump water from the canal and fuel oil from the storage tanks on the Freeport ship channel to the mines, providing power for the machine shop and for commercial and domestic lighting and power at Freeport. The station will be installed by the Westinghouse Church Kerr Company, of New York.

PERSONALS.

HUGH L. COOPER, the engineer whose name has been made famous on account of work done at Niagara Falls, N. Y., and at Keokuk, Iowa, in connection with the Mississippi River Power Company's development, has opened offices at 101 Park Ave., New York City, where he will engage in the practice of general engineering, including the design, construction and management of hydro-electric power plants.

MR. HAROLD ALMERT, consulting engineer and for the past five years manager of the department of examinations and reports of H. M. Byllesby & Co., has severed his connection wtih that firm to engage in consulting engineering practice on his own account, with offices in The Rookery, 209 So. LaSalle St., Chicago, Ill. Mr. Almert is just completing his twentieth year of active work in the organization, financing, design, construction, operation and management of public utilities, and for several years past, has valued or passed on investments for new projects, consolidations, reorganizations or extensions to existing properties of from one hundred to two hundred million dollars, annually. His practice before Public Utility Commissions, which extended from New York to California, and he has handled many rate important rate cases, served as arbitrator in a number of condemnations, and in these lines has established a new and important field of usefulness for the engineer with training in law and accounting, as well as technical training and experience. As assistants, Mr. Almert will have associated with him a staff of well seasoned specialists in mechanical, electrical, gas and hydraulic engineering, appraisals, rate investigations, accounting and efficiency work..

J. E. MAIR, sales engineer, Appleton Electric Company, Chicago, Ill., is making a trip through the Southeast, calling on jobbers and supply dealers in all the important cities. Mr. Mair spent the month of January in Texas where he reports active work along electrical lines. On his way to the Southeast, he stopped at New Orleans, Mobile, Montgomery, Birmingham and Atlanta, in which cities his company has made important connections with electrical jobbers. From Atlanta he will return to Chicago, stopping at the important points on the way. The office of Electrical Engineering was favored with a call from Mr. Mair while in Atlanta, according to an established custom, which was enjoyed in a business and social way, for this gentleman possesses a vast amount of information on electrical conditions in his territory, which includes the Southern states from the Atlantic to the Pacific coast. He is always most optimistic when discussing all subjects, a reason perhaps for the many friends he has in the South.

MR ARTHUR ORGAN, of the Hunter Fan and Motor Co., 114 Liberty St., New York City, plans to make a trip through the South during the early part of this month calling on electrical jobbers. Those jobbers who are interested in a fan motor proposition of merit can secure a call from Mr. Organ by writing the company's New York office which will in turn keep Mr. Organ advised during his trip.

MR. O. P. WILSON, of the purchasing department of the Westinghouse Electric & Manufacturing Company, has resigned to accept the position of assistant general manager of the Norma Company of America, 20-24 Vesey Street, New York City, manufacturers and importers of high-grade ball bearings, roller bearings, precision instruments, etc. Mr. Wilson has been connected with the Westinghouse Company for fourteen years and for the last ten years has been one of their head buyrs.

MR. W. W. WINSHIP, sales engineer for H. T. Paiste Company, Philadelphia, is making an extensive business trip throughout the South investigating conditions in the electrical field and calling on jobbers who are interested in the Paiste products. Mr. Winship reports considerable activity among electrical contractors and a growing tendency to adopt those devices that enable them to do good work at a reasonable cost. The Paiste line of "taplets," sockets, etc., he says, has appealed to the Southern contractor and jobber on this account. Mr. Winship has visited Jacksonville, Savannah and Atlanta and will remain South for some weeks visiting other cities.

SHIRAS MORRIS, who has been secretary and treasurer of the Hart and Hegeman Mfg. Co., of Hartford, Conn., for some years has been elected president of the company. Also McKew Parr, formerly advertising manager, becomes general sales manager.

Mr. Morris is a graduate of Trinity College of the class of 1896. In the same year he became connected with the Pope Mfg. Co. as advertising agent and one year later went with the Hart and Hegeman organization. In two years he was chosen secretary of the company. Two year later he was re-elected secretary, with the duties of treasurer added. His services as secretary and treasurer have been so satisfactory to the stockholders that his promotion to the presidency has been a foregone conclusion since the vacancy in the office caused by the death of Mr. Pease. Mr. Morris is secretary and treasurer of the Kinsler-Bennett Company, vice-president of the Hartford Chapter of the National Association of Credit Men, treasurer of the Manufacturers' Association of Connecticut, and a member of the directorates of the American Industrial Bank and Trust Company, Industrial Realty and Title Guarantee Company, New England Sheradizing Company, New Haven Sheradizing Company and the Hartford Young Men's Christian Association. He is a member of the board of fellows of Trinity College, Hartford Board of Trade, Hartford Business Men's Association, Hartford Club, University Club, Hartford Golf Club, Republican Club of Hartford, and the Jovian Order.

Mr. Parr is a native of Baltimore and became associated with the company as its Southern representative in 1909. He was graduated in the class of 1906 at the United States Military Academy at West Point. Previous to his connections with the Hart & Hegeman Manufacturing Company he was with the "Baltimore Herald." He has been connected with the Merchants' National Bank of Baltimore, Maryland Telephone Company of Baltimore, Southern Electric Company of Baltimore, and Cataract Electric Supply Company of Buffalo. After representing the Hart & Hegeman Company in its Southern territory for two years, he was appointed advertising manager and continued in that capacity until his promotion. While Mr. Parr is one year short of 30, his experience in the electrical business has been long and valuable. He is a member of the Baltimore Club and of the Maryland Society of the Sons of the American Revolution. He is a director of the Jovian Order and a member of the Charter Oak Ad Club.

MR. J. C. BUERKE of Hampton & Buerke, engineers and electricians of Tampa, Fla., reports the securing of a contract to install a "White Way" through "Wallcroft" a real estate subdivision on the Bay Shore Boulevard. The interurban electric line to Port Tampa follows this drive, skirting the edge of Tampa Bay as far as Ballast, some 5 miles from the city. A contract to wire the new Mugge hotel building is also reported.

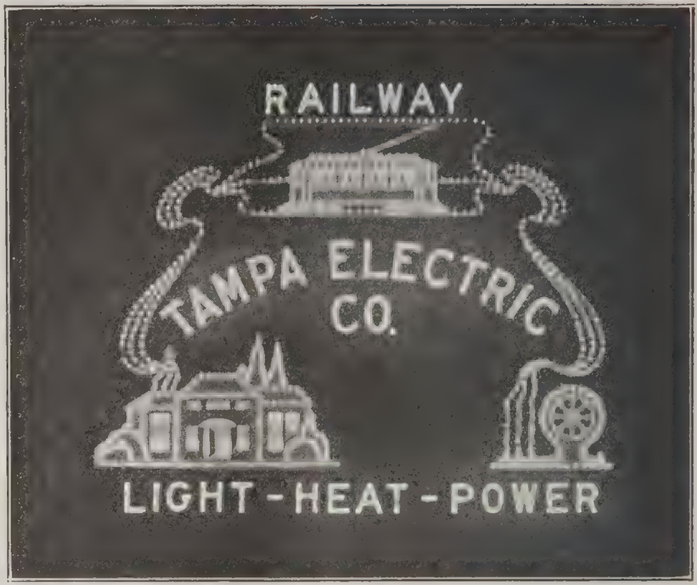
MR. J. H. W. REES, until recently, advertising manager of Deuth & Company, importers of incandescent lamps, and formerly executive advertising manager of the National Progressive Party, has been made general manager of the United Electric Lamp Company, Bush Terminal Bldg., 253 36th St., Brooklyn, N. Y. Mr. Rees is well-known in both the commercial and industrial fields of activity and under his managerial direction, the success of the United Electric Lamp Company is assured. The company, which is operated along independent lines, is handling the entire output of a well known genuine wiredrawn domestic tungsten lamp.

Industrial Items.

THE DIEHL MANUFACTURING COMPANY of Elizabethport, N. J., advises that the edition of bulletin No. 505 mentioned on page 68 of the January issue of Electrical Engineering, is now exhausted and copies cannot be supplied. A new edition will soon be available.

THE TERRY STEAM TURBINE COMPANY, of Hartford, Conn., calls attention in bulletin 17 issued under date of October 1913, to the features of design embodied in the Terry return flow steam turbine. It is said that the leading turbine builders in Germany and Switzerland are adopting for condensing turbines, a combination of a multi-velocity stage element for the high pressure end with a series of multi-pressure stage elements in the low pressure end. This principle of design in the small turbine field, that is in machines of 500 Kw. and under, is said to have been first adopted in this country by the Terry Steam Turbine Company. The advantages claimed for the return flow over the straight flow designs, is in the eliminating of the possibility of air leakage to the condenser through the low-pressure end.

THE DELTA-STAR ELECTRIC CO., Chicago, Ills., is distributing a new folder devoted to a concise description of their "unit type" bus bar supports and phase rotation indicator. Full directions for using this indicator are incorporated and will be of use to operating engineers.



Did You Ever See an Electric Sign With More
Individuality

The Company's name burns steadily; the generator revolves, typifying power; the electricity seems to flow through the wires to light up the house and the street car is fully brought out. This sign fulfills its mission most thoroughly, giving a finishing touch to the splendid new office building, upon which it stands, and advertising the company's service to all who are abroad.

Greenwood Electric Signs
THEY'RE DIFFERENT.
GREENWOOD ADVERTISING CO.
Knoxville, Tenn. Two Factories Los Angeles

THE STEVENSON COMPANY, Wilkesburg Station, Pittsburgh, Pa., has issued an 8-page booklet devoted to Stevenson moulded insulation and other moulded parts. This insulating material is high heat resisting, non-hygroscopic, impervious to oils, moisture and most chemicals. It is claimed that it will not warp, soften, decay or otherwise deteriorate with age. It can be readily drilled, tapped, machined or buffed to a very high finish and is made up in such designs as are shields, spools, base blocks, tubes, and sheets of any reasonable size and thickness.

THE EASTERLINE CO.., Indianapolis, Indiana, has issued folder No. 312 entitled "Esterline Efficiency Ideas," which discusses in eight pages the use of graphic meters. This company has made a study of graphic instruments for 15 years in connection with possible applications in the electrical industry and on this account has vital information to present to those interested. To secure a record of line voltage, station curves, consumers' load curves, maximum demand, current delivered to arc circuits, traffic conditions on electric traction lines, investigations in electrolysis, and details of shop tests, the graphic instrument in suitable types is essential. Folder No. 312 taking up these matters may be secured by writing the above company.

DOOR SAFETY SWITCHES. An 8-page pamphlet on door safety switches for use with electric elevators has just been published by The Cutler-Hammer Mfg. Co., of Milwaukee. A great majority of accidents on all types of elevators are the result of setting the elevator machine in motion before the doors are closed and locked and the passengers clear. With the ever-increasing number of passengers the safety feature is of utmost importance.

ELECTRIC HOUSEHOLD HELPS is the title of a little folder (No. 4197) just issued by the Westinghouse Electric & Mfg. Company, illustrating the use of electrical devices in the household. The little pamphlet is profusely illustrated with views of the devices and also of their application. The reading matter describes the cooking of breakfast, dinner, supper, lunches, and also treats of the uses of these devices in the boudoir, sewing room and other rooms about the house. A complete price list is

"Small Motors" No. 18 covers the application of small a. c. and d. c. motors. A detailed description is given of the construction of these motors accompanied by photographs of the various parts. There is also given the application of these motors to various devices such as washing machines, vacuum cleaners, piano players, pumps, sign flashers, and ironing machines.

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(Seal) (My commission expires June 24, 1916.)

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Springtime is Fan Time—How About Repairs?

Springtime is fan-time—it's the time when central station managers begin to think about ways and means to connect to their lines such apparatus as will represent a kilowatt hour consumption at least equal to the reduction due to short hour burning of electric lights, and in these ways and means the electric fan plays an important part. Likewise the electrical dealers, on account of past experience in handling fan demands, get busy in springtime selecting a profitable fan account and signing up a new contract. It's the time when the housewife and office manager get out last year's fan, or the one of year before or the year before that and places it in position ready for operation when the first hot day comes, and it's the time when those who have no fan in storage begin to think of same in terms of cool breezes and the cost, at the suggestion of timely spring fan advertising. Springtime is in truth fan-time.

While the dealer and central station is planning on piling up a larger volume of fan sales during this year, they are in many cases at this time neglecting an opportunity for good business before the season sets in in real earnest. We refer to fan repair business. The fan is used in a majority of cases by those who know little about its mechanism and pay little attention to its condition. When the housewife gets out her last season's hat, she either discards it altogether or spends a considerable amount in making it wearable for the new season. We men carefully lay away our winter overcoats with the necessary precautions against moths, and get out our spring suits when such are worthy of further service, and clean and press same. With the electric fan, no such consideration is given. In the fall it is laid away in some out of the way place, in store room or closet to collect dust and dampness, and at the first sign of hot weather, dug out, plugged in and set to work, with perhaps a few puffs of breath to remove the surface dust of some six months or given a "lick and a promise" motion with a dust rag. If it purrs away as it did last year and the year before that, well and good—if it does not—"Well, that fan was never any account and the fellow that sold it stung us and we do not go back again to supply our electrical wants."

This is a problem strictly up to the dealer and central station manager who sells fans. It is one that can be completely solved at a profit and further be turned into a good asset in selling future customers, for what housewife or what office or factory manager will not appreciate an extension of the life and satisfactory operation of any device at a reasonable cost and tell a neighbor of the economy? Further, those dealers and central station managers who are far-sighted enough in this direction to call on custoers in the fall and offer to clean, repair and store fans and connect same to sockets in the spring as good as new, can hardly estimate the indirect return in good feeling created and appreciation due to the fact that such a dealer or central station manager indicates a desire not only to sell fans that will work when new, but also to make sure that each year they are in a condition to do what was claimed for them when sold. These are features of particular merit to central station managers over and above the fact that fans in good repair will be kept in operation more hours per year than fans which give trouble frequently, and require continual tinkering.

This is the time of the year when an "envelope stuffer" mentioning the fact that fans may be repaired at small cost, will create real publicity. At least one fan manufacturing company has realized this and is offering to furnish free to dealers and central stations such stuffers for circulation, if their fans are used. A good repair department cannot be built up in a minute, but there must be a start made sometime, somewhere. Why not take advantage of this opportunity, and when the inquiries come in, send out a mechanic to inspect the fans and repair those that need repair and advise users of the advantage of properly storing and repairing their fans next fall?

Burning Lamps at Proper Voltage.

During the past few years remarkable progress has been made in the art of incandescent lamp manufacture. The lamp of today has a neat, attractive appearance and possesses remarkable strength and toughness. The filament is of drawn-tungsten wire and operates at about three times the efficiency of the old carbon filament. Further, the advancement in lamp operation has not been confined entirely to the lamp itself for the conditions of actual service have through careful investigation been analyzed in such detail as to enable the manufacturers of lamps to give them a rating which will be most satisfactory under certain operating conditions.

Fortunately the voltage rating on a lamp is not now arrived at by guess work. It is the result of scientific research, and means that if the lamp is burned at that voltage it will give its rated candlepower at its rated efficiency, and last its rated life. If, in selecting lamps, care be taken to select lamps of such a voltage that the average life will be about normal, then the candlepower, efficiency and wattage, due to their electrical relationship, will also be about normal. The question, then, of selecting the proper lamp for a circuit resolves itself into the determination of the voltage for which lamps should be ordered so that the average life of all may be normal.

It has been shown, in investigations and discussions, notably those recorded in a recent bulletin by the engineering department of the National Electric Lamp Association bearing on the subject of these remarks, that a lamp burning at a certain percentage over voltage loses more of its life than is compensated for by burning at the same percentage under voltage for an equal length of time. In circuits carrying heavy power loads in combination with lighting loads, the fluctuation may be enough to warrant serious consideration. As a general rule, however, it may be stated that the difference between the scientifically correct or "effective" lamp voltage and the average line voltage during lighting hours will not amount to more than one volt unless the circuit fluctuates more than 6 per cent above and below this average value.

The individual customer of a central station is, in general, concerned only with voltage fluctuation as regards time, whereas the management of the central station itself must consider not only the variation with respect to time, but also with respect to distance. In the case of heavily loaded circuits where the voltage varies considerably at different points along the line, it is not uncommon to use different voltage lamps for different localities. This necessarily results in some inconvenience to the central station, and at best is a difficult proposition to handle. It is usually a question of local conditions as to whether this policy can be advantageously followed.

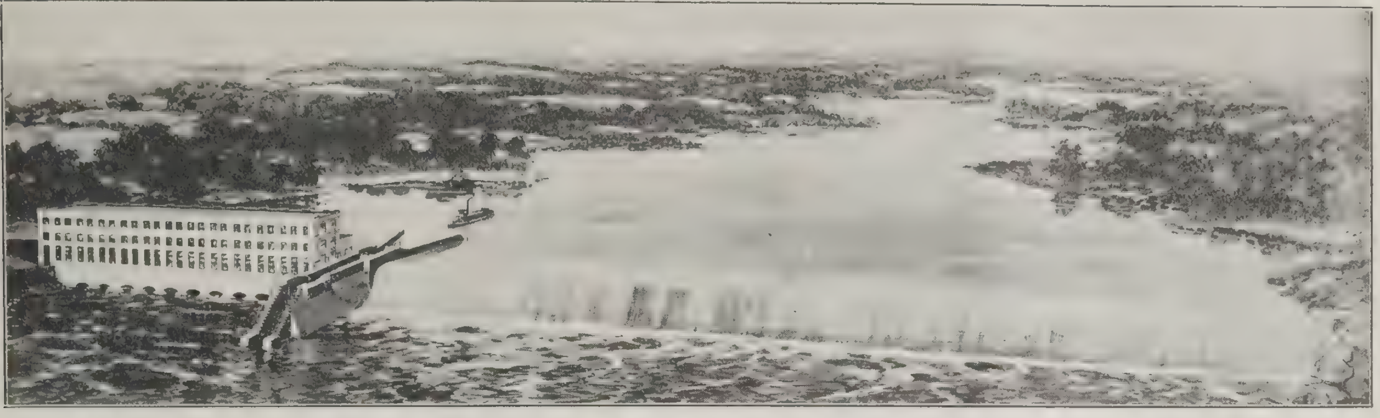
In general there are two other factors that must be considered in determining the effective voltage of a circuit—the number of lamps, and the hours of burning. If we consider a circuit where the voltage varies considerably and which has a large number of lamps at one location and only a few at another, it is at once apparent that the voltage at which the largest number of lamps burn must be given the most weight in determining the proper lamp voltage. Further, if in the above illustration, the greater number of lamps burn more hours every day than the smaller number, this fact should also be given consideration.

In order to determine absolutely the proper lamp voltage it would be necessary to take voltage readings on the premises of all the customers of the station at intervals of a few minutes throughout a day, and this would have to be repeated several times during a year in order to take account of seasonal variations of load. Obviously, an investigation of such magnitude would be out of the question, and some approximate method must be used. The number of localities at which readings are to be taken may be lessened by taking the readings at the center of the load, or "center of gravity" of each feeder. The high voltage between the station and the center will compensate for the low voltage beyond the center. The readings so taken should be properly weighted and the correct lamp voltage determined.

Those who have worked themselves up to a point where they believe that lamps operated at a voltage below their normal rating have a longer than rated life, should investigate this subject of proper voltage. In short such a policy is first, poor practice and secondly, faulty engineering for it results in a loss of efficiency and consequent increase in cost of current per unit of light which more than offsets the saving in the cost of the lamp. Burning lamps at their highest rated voltage means, in general, not only more light for the money to the customer, but also an increased profit to the central station.

Plans for Southern Train to Philadelphia N. E. L. A. Convention Well Under Way.

The plans for the Southern train to the Philadelphia convention of the National Electric Light Association are now well under way, and reservations are constantly coming in, with the largest number of prospects not yet heard from. Southern Transportation Manager A. H. Sikes is following up the first announcement with letters, so that all wil lbe given an opportunity to make arrangements early. The transportation committee is soon to meet in New York and make a choice of routes for the train and make a contract for same, when the railway company will start its campaign of solicitation for passengers. Every Southern central station man who plans to go to Philadelphia the first week in June should co-operate to make this train a decided success.



Stevens Creek Development on the Savannah River Near Augusta, Ga.

Two Southern Low Head Hydro-Electric Developments Just Completed

BY GEORGE G. SHEDD, SUPERVISING ENGINEER, J. G. WHITE ENGINEERING COMPANY.

Engineering Details of a Development on the Savannah River and One on Broad River, S. C.

On February 16 about 400 Augusta (Ga.) business men, as guests of the Augusta-Aiken Railway & Electric Corporation, witnessed the formal starting of apparatus in a recently completed hydroelectric plant on the Savannah River nine miles above the city. This development is known as the Stevens Creek development, and has been constructed by the J. G. White Engineering Company, of New York City, for the Georgia-Carolina Power Company, a subsidiary of the Augusta-Aiken Railway & Electric Corporation. The excavation work for the dam was started in December, 1912, and the first concrete poured February 20, 1913. With only three serious interruptions, due to high water, the work was rushed to completion in advance of schedule and the apparatus placed in operation in just twelve months from the time actual construction work began.

[The completion of the Stevens Creek development represents the accomplishment of a plan laid down by the J. G. White interests some four years ago, when the street railway and light and power properties of Augusta were purchased and the Augusta-Aiken Railway & Electric Corporation formed. From that time the policy of the company has been one of expansion and improvement of facilities, having spent about $1,000,000 in enlarging power plants, and installing overhead and underground distribution work in Augusta proper, besides some $3,500,000 to make possible the hydroelectric development already mentioned.—Editor.]

At practically the same time that the J. G. White Engineering Company started work on the Stevens Creek plant, another construction force, under the same management, began work on a contract to construct a similar development on the Broad River near Columbia, S. C., for the Parr Shoals Power Company, authorization to proceed with these two projects having been received at about the same time, the latter part of June, 1912. Construction forces were immediately organized, camps built, wagon roads and railroads constructed in order to deliver material and plant as cheaply as possible. As both projects were away from settlement of any size, it was necessary to provide accommodations for practically the entire force. At Stevens Creek the maximum number of men employed at one time was about 800 and at Parr Shoals about 1,100, which, with the families, made a total population to provide for of about 1,200 and 1,500 people, respectively. Bunk houses were provided for unmarried laborers, and houses having from one to five rooms were built and rented to the married men for from $2.00 to $12.00 per month. Four permanent houses were built on each job for the future use of the power house operators, and were used during construction by the superintendents and engineers. Boarding houses, a butcher shop, bake shop, refrigerating and ice plant and commissary were built. Great care has been taken to safeguard the health of the camps; pure filtered water and sewerage systems were provided, and a hospital, fully equipped, with a resident physician always in attendance. As the Stevens Creek camp was only a mile or two from the intake of the Augusta water works, additional precautions had to be taken to safeguard Augusta. For this reason incinerators were provided, and a filter bed used to purify

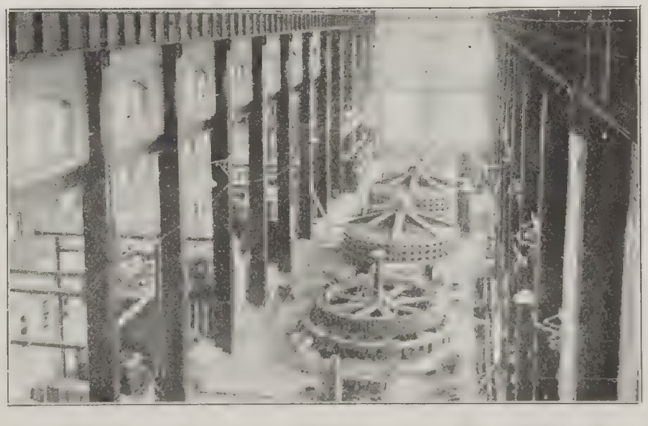


Fig. 1. Operating Floor of Stevens Creek Station.

wash water from the sewerage system. A sanitary inspector enforced all sanitary regulations. The wisdom of these precautions has been proved by the remarkable freedom from sickness in both camps. Malaria was very prevalent in the vicinity about both camps, but by using methods similar to those found so effective at Panama, this has given no trouble, except for the first few months at Stevens Creek, before the camp site could be properly cleaned up and the men educated to take proper precautions. For the protection of the camp, a fire brigade was organized; telephones and electric lights were also provided; and, to keep the men contented, athletic sports were encouraged, such as baseball, football, tennis and trap shooting.

Work was started on the cofferdam at Parr Shoals the latter part of July, but could not be started at Stevens Creek until the War Department approved plans, which was about the first of September. The first enclosure was completed at Parr Shoals in November and at Stevens Creek early in December. In both cases the enclosures covered the site of the power house, sluice gates and a section of the dam. The design adopted for the upper coffer consisted of a series of rock-filled crib piers, with 12-foot openings between, which were later closed by stop logs, or open cribbing, with the up-stream face sheathed and toefilled. Later, and before the final enclosure was made, these openings were shot out, and the water passed through to the sluice gates and temporary openings which had been left in the dam for this purpose. The balance of the cofferdams were usually a solid rock-filled crib section, as this type can be built cheaper and faster than the piers. A small amount of earth-filled crib coffer was used. The coffer ranged in height from 6 feet to 27 feet, but usually was from 14 to 17 feet high. A total length of over two miles of cofferdams was built on these two jobs, and the speed with which they could be built largely governed the progress of work on the dams.

Quarries and sand pits were opened, and very efficient stone crushing and concrete mixing plants were set up, having a capacity of 1,000 cubic yards of well-mixed concrete per day. From the mixer the concrete was dumped in 2¼ yard buckets on flat cars, in trains of from four to six, and hauled by dinkies to site of work, and deposited in place by stiff log derricks. Eight locomotives on each job, of various tonnages from ten to forty, were used in this and on other features of the work. Concrete work commenced at Parr Shoals on February 5, 1913, and at Stevens Creek on February 20, and continued practically uninterruptedly, as already stated. While the Stevens Creek plant has been started, the one at Parr Shoals will not be in operation until the work of raising and relocating about five miles of Southern railway is completed.

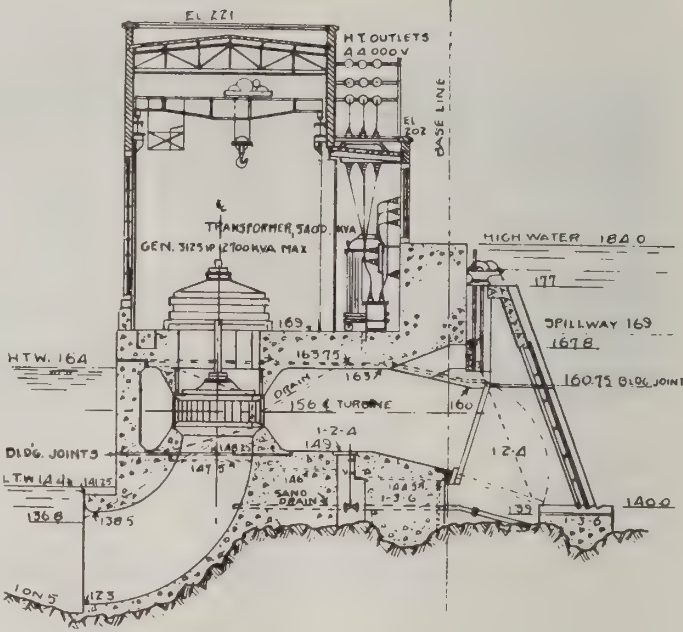


Fig. 2. Section Through a Main Unit of Stevens Creek Power House.

STEVENS CREEK DEVELOPMENT.

The Stevens Creek development, with an ultimate capacity of 31,000 horsepower, will supply the power market centering about Augusta, Ga. Its location and construction takes advantage of the drainage area of the Savannah River, including that of Stevens Creek, of about 7,200 square miles, at the site of the plant. This area is to a large extent rolling country, the upper part being rough and largely covered with forests, while the lower part is

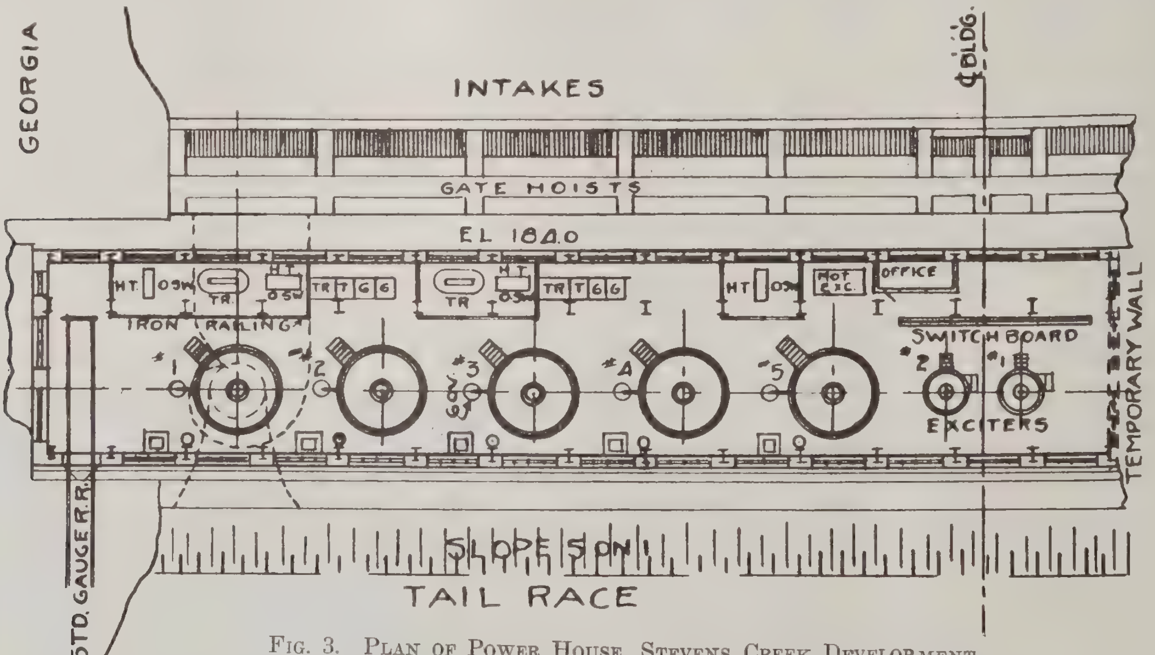


Fig. 3. Plan of Power House, Stevens Creek Development.

cleared and under cultivation. The lowest daily flow recorded during the period 1892-1912 was 1,610 cubic feet per second, on October 12, 1904, and the highest 318,000 c.f.s., August 27, 1908. The lowest average monthly discharge during the period from 1884 to 1912 occurred in October, 1904, and was 2,080 c.f.s., and the highest average monthly flow 46,360 c.f.s., in September, 1888.

The average horsepower available for the development has been computed for a period of twenty-seven years, and, on a basis of load factor of 33⅓ per cent, is found to be very rarely less than 20,000 delivered horsepower. The location chosen for this development is just below the confluence of Stevens Creek with the Savannah River, and practically at the foot of a long series of rips in the main river. This location was determined to be the most economical and safest after detailed surveys and numerous borings and soundings had been made.

GENERAL DESCRIPTION.

In brief, the development consists of a dam having a total length, including power house, of 2,700 feet; a power house designed for an ultimate equipment of 31,000 horsepower, with a present installation of 15,600 horsepower, and the lock, 30 feet wide and 150 long in the clear. A pond, created by the dam, extends about fourteen miles up the Savannah River and about thirteen miles up Stevens Creek, and will have a surface area of about 4,200 acres.

The dam is constructed of Cyclopean concrete, the spillway section being 2,000 feet long, of the Ogee type, with an average height of about 30 feet and a maximum height of 47 feet. At the average height the sectional area is 619.5 square feet and the base width 35.43 feet. The nonoverflow sections have a combined length of 233 feet, with crest elevation 15 feet higher than the spillway. The dam was designed to pass safely a freshet of 450,000 c.f.s., which is almost 50 per cent larger than the greatest freshet on record—that of August 27, 1908, estimated to be 318,000 c.f.s. It is estimated that the 1908 freshet would cause a depth over the crest of 11.3 feet.

In order to assist in operating flashboards on the dam, as well as to aid in taking care of water during construction, and to provide a means for complying with the government requirement that no water shall be stored when the flow is below a certain specified limit, five sluice gates, 8 x 8 feet each, with Venturi setting, are provided through the spillway section adjacent to the lock, and are operated at present by hand from a tunnel in the dam, provision being made, however, for a future motor operation. Provision is made for the future use of flashboards, and sockets are also provided for guard pins to safeguard the men when operating flashboards. At the request of the United States War Department engineers, deformed uplift bars, having an equivalent sectional area of 0.625 square inches per lineal foot of dam, are placed vertically three feet from the up-stream face of dam, extending seven feet into the ledge and fifteen feet or more into the dam throughout the length of the dam and lock walls.

Great care has been used to secure a good foundation throughout. The ledge is principally an excellent quality of granite and schist, but at three points, one in each of the principal channels, it was necessary to remove from ten to twenty feet of disintegrated rock before securing a good foundation. As a preliminary to foundation work, test holes are drilled to determine character of ledge and to locate any possible seams. If necessary, to determine extent of seams, Magenta dye has been forced in under pressure. This method has been very satisfactory, in that the character of the ledge, being known in advance, has prevented unnecessary drilling and excavation, and has also disclosed the presence of several dangerous, smooth, horizontal seams, to which it was necessary to excavate the ledge in order to prevent possible uplift and sliding. These test holes, as well as other holes, where necessary, were grouted

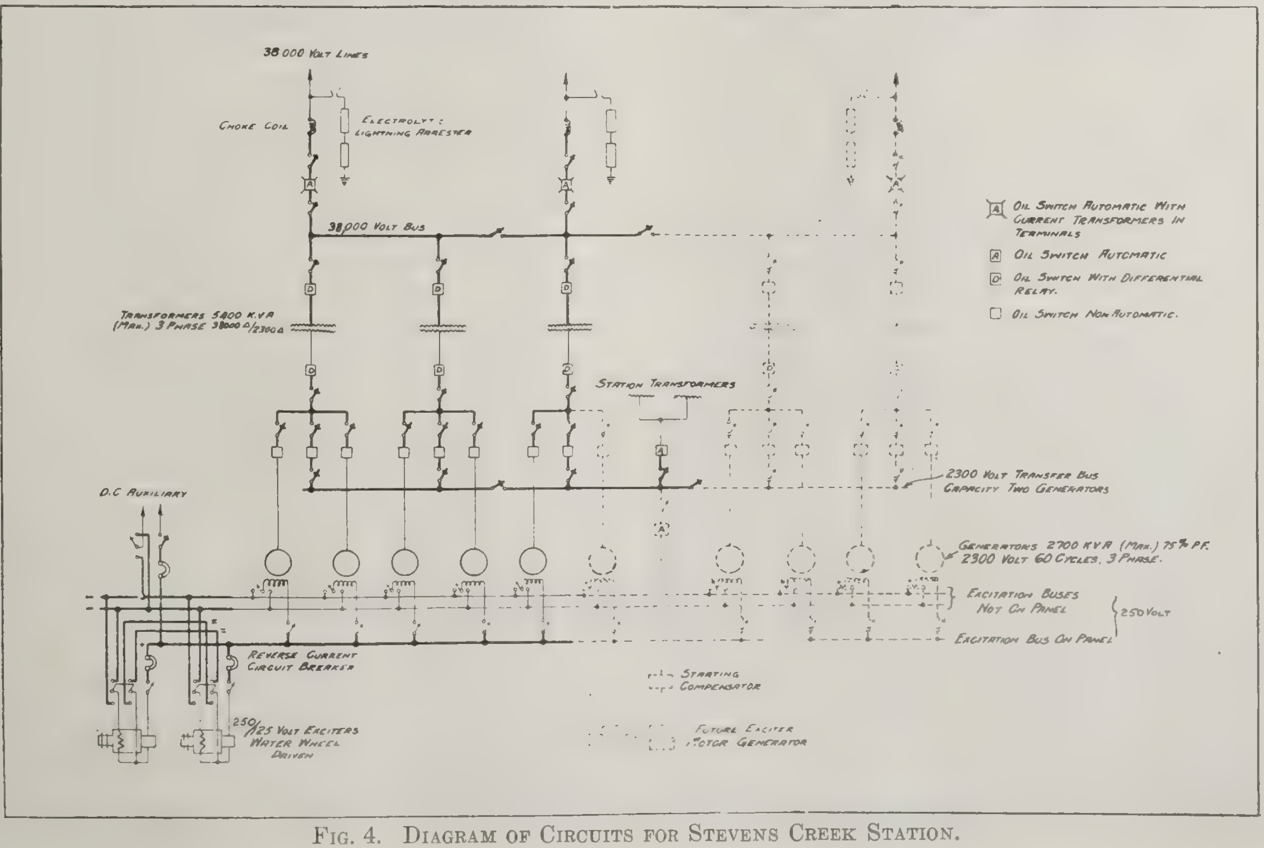

38 000 Volt Lines
Choke Coil
Electrolyt : Lightning Arrester
38,000 Volt Bus
Transformers 5400 K.V.A (Max.) 3 Phase 38000 Δ/2300 Δ
A
D
Station Transformers
Oil Switch Automatic With Current Transformers In Terminals
Oil Switch Automatic
Oil Switch With Differential Relay.
Oil Switch Non Automatic.
2300 Volt Transfer Bus Capacity Two Generators
D.C Auxiliary
Generators 2700 K.V.A (Max.) 75% P.F. 2300 Volt 60 Cycles, 3 Phase.
Excitation Buses Not On Panel
250 Volt
Excitation Bus On Panel
Reverse Current Circuit Breaker
Starting Compensator
250/125 Volt Exciters Water Wheel Driven
Future Exciter Motor Generator

FIG. 4. DIAGRAM OF CIRCUITS FOR STEVENS CREEK STATION.

under 100 pounds air pressure. Whenever necessary to prevent possible sliding, trenches have been cut in the ledge. It is believed that by these methods a very secure foundation has been secured at a minimum cost.

To meet the requirements of navigation, a concrete masonry lock has been constructed adjacent to the power house. The lock is 30 feet by 150 feet in the clear and has a lift of 27 feet. There will be at least 6 feet of water over the lower mitre sill, and the upper mitre sill is 12.5 feet below the masonry crest of the spillway. It will be filled and emptied by means of a 6 by 6 culvert and ports, leading into the side of the lock, and controlled by gates set in gate wells near the lock gates. Heavy wooden lock gates have been provided, to be operated by hand winches.

THE POWER HOUSE.

The power house is designed for an ultimate installation of ten 3,125 horsepower, vertical main units and two 450 horsepower exciters. The substructure is built complete for a superstructure 51 by 388 feet in plan, and consists in its lower part of Cyclopean concrete and its upper part of reinforced concrete. The superstructure at present is built for five units and two exciters only, and consists of a steel frame with brick walls, and is provided with a 50-ton electric traveling crane.

The turbines were furnished by the I. P. Morris Company, and are of the vertical, single runner, 75 r.p.m., single discharge type, 104 inches in diameter, set in a concrete spiral casing, and provided with concrete draft tubes. The efficiency is expected to be better than 86 per cent. Each unit is provided with a double floating lever, oil-operating governor, which can be controlled from the switchboard or by hand. A central oil pumping pressure system is provided, working normally under an oil pressure of 200 pounds. All operating parts of the turbine are accessible for quick repair if necessary, making it unnecessary to unwater the wheel casing, with the one exception of accident to runner. The exciter turbines are 450 horsepower, 40 inch diameter, 200 r.p.m., of a type similar to main turbine.

The electrical equipment of the first installation consists of five Westinghouse, vertical type, revolving field, 3-phase, 60 cycle, 2,300 volt, 2,700 Kva. (at 75 per cent power factor) generators; two 300 Kw., 250 volt, vertical type exciters; three 5,400 Kva. transformers, stepping up from 2,300 volts to 44,000 volts. All wiring, where possible, is installed in conduits, buried in the concrete floor.

TRANSMISSION LINE.

The transmission line to Augusta is approximately seven miles long, with Milliken type, galvanized steel towers, designed for two circuits, with three wires on each side. The height to the lowest cross-arm is 50 feet. The tower spacing is approximately ten per mile. At the Lake Olmstead crossing special towers are provided, 80 feet high, for the span of 960 feet. In the city, along the canal, latticed steel poles, spaced 200 feet apart, are used. The wire for the power circuits is No. 1/0, 17 strand medium hard drawn copper, and the ground wire is 5/16 inch, 7 strand copper clad cable, having 30 per cent conductivity. A telephone circuit is run on the towers, 10 feet below the lowest power wires, and is transposed at every tower, and all instruments are protected by transformers. The power circuits have one complete transposition between the power house and the substation, and are hung on Thomas No. 1118 suspension type insulators.

THE AUGUSTA SUBSTATION.

The Augusta substation is located adjacent to the steam plant of the Augusta-Aiken Railway & Electric Corporation. On account of the limited ground space, the building was designed with two galleries. There will ultimately be installed three banks of transformers of three each, 2,000 Kva., single phase, stepping down from 44,000 volts, 3 phase, to 13,000 volts, 3 phase. Only one bank of three transformers is at present installed. Provision is also made to step down from 13,000 volts to the existing circuits in Augusta of 2,300 volts, 2 phase. All of the switches in the substation are remote control and will be controlled from the switchboard in the steam station. All apparatus in the substation is furnished by the General Electric Company.

Parr Shoals Development.

The Parr Shoals development is located about 1½ miles up stream from Peak and Alston, S. C., and 27½ miles above Columbia. The drainage area at this point is estimated to be 4,570 square miles, and is in its upper part mountainous, largely covered with forests. The lower part is flatter, and a considerable portion is under cultivation. Very good records of run-off are available, particularly at Alston, from 1896 to 1907. The lowest recorded average weekly flow occurred in October, 1907, and was 1,260 cubic feet per second. The lowest average monthly flow occurred in October, 1904, and was 1,614 cubic feet per second. The greatest flood on record occurred on August 27, 1908, and from local information was about 32.7 feet above the extreme low water mark at Alston of 1907. The discharge is estimated to have been about 222,000 cubic feet per second. Based on past records, and a weekly load factor of 33⅓ per cent, the delivered horsepower at Columbia will be only occasionally less than 20,000 horsepower.

GENERAL DESCRIPTION.

The development consists principally of a dam with a total length of about 2,740 feet, including the power house; a power house 300.5 x 51.6 feet in plan; a tailrace which is obtained simply by widening and deepening the original east river channel; a double circuit steel tower transmission line, 26 miles long, to Columbia, and a substation at Columbia.

The dam is constructed of Cyclopean concrete throughout. The spillway section is of the Ogee type, 2,000 feet long, with an average height of about 39 feet and a maximum height of about 55 feet. A short section of non-overflow dam, with its crest 14 above the spillway, is constructed between the power house and the east shore, and an earth embankment with a maximum height of 20 feet and total length of 300 feet has been built on the west shore. The dam contains six sluice gates adjacent to the power house, with a clear opening of 7 x 9 feet each. These have a combined capacity of about 14,400 cubic feet per second, with headwater at the crest of the dam, and tailwater at normal level. The operating devices for the sluice gates are located within the dam, and the crest of the dam is fitted with the flashboard sockets, which will later be used for five feet of flashboards.

The dam is designed to safely pass a flood considerably in excess of the maximum flood on record, which would have caused a depth of about 9.0 feet over its crest. The concrete for the dam has been mixed in proportions of one part Portland cement, three parts sand and six parts broken stone. In the concrete has been embedded about 7 per cent

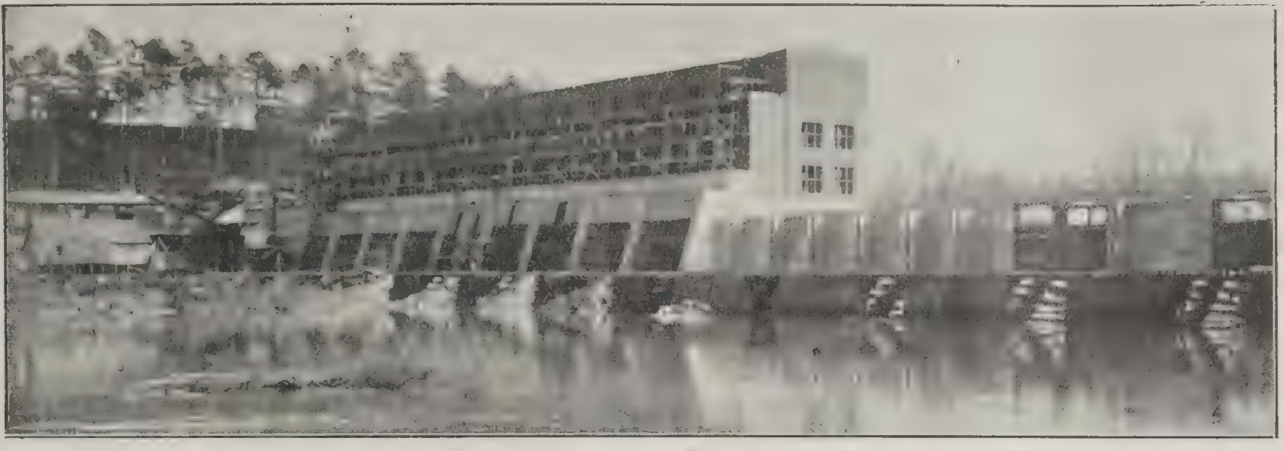


FIG. 5. POWER HOUSE OF PARR SHOALS DEVELOPMENT ON BROAD RIVER, NEAR COLUMBIA, S. C.

of plums, consisting of large, sound pieces of rock, or boulders, in many cases weighing six or eight tons each. The foundation is principally of an excellent quality of granite and schist, and methods similar to that described for Stevens Creek were used in preparing the bottom.

THE PARR SHOALS POWER HOUSE.

The power house is designed for an ultimate installation of eight vertical type units of 3,100 Kva. each and two vertical exciter units of 300 Kw. each. The substructure is a combination of Cyclopean and reinforced concrete, and the superstructure is a steel frame, with brick walls. The roof for the main portion of the building is of hard pine, and that for the low portion, or gallery, is of concrete. Both are water-proofed with five-ply tar and gravel covering.

The turbines are of vertical shaft, 86 inch diameter, single runner, downward discharge type, set in reinforced concrete, scroll case flumes, and have draft tubes molded in concrete, so proportioned that the velocity is gradually decreased to five feet per second. The flumes are controlled with large steel gates (14 feet by 25 feet), hinged at the bottom, and operated by means of a traveling hoist running on tracks on the head wall. Two filler gates, 4 x 7 feet each, are provided in each unit. Screen racks are also provided, supported by reinforced concrete piers, and protected at the top with a reinforced concrete curtain wall. The turbines are designed to run at a speed of 100 r.p.m., and will furnish 3,600 b.h.p. at 35-foot head with an efficiency of 86 per cent.

The governors are located on the main floor, and arranged to be controlled from the switchboard, although hand control is also provided. They are of the oil pressure double floating lever type, with a central oil pumping and pressure system, operating normally at 165 pounds pressure. They are designed to control the speed within very narrow limits, and eliminate entirely any hunting or racing tendency which causes so much wear and tear on the gate rigging.

The electrical apparatus of the first installation consists principally of five vertical type, revolving field, 3-phase, 40 cycle, 2,300 volt, 3,100 Kva. (at 75 per cent power factor) generators; two vertical type, 300 Kw., 300 r.p.m., 125 volt exciters; three transformers, 6,200 Kva., 3 phase, stepping up from 2,300 volts to 66,000 volts. The generators and hydraulic equipment and the necessary auxiliaries and switching apparatus were furnished by the Allis-Chalmers Company and the switching apparatus by the Westinghouse Company.

TRANSMISSION LINE.

The transmission line is being built at present to Columbia, and consists of Milliken type, galvanized steel, double circuit towers. The towers are spaced approximately 9.5 to the mile, with a height to the lowest cross-arm of 50 feet. In the city latticed steel poles are used, spaced about 200 feet apart. Stranded medium hard drawn copper wire No. 1/0, 17 strand, is used for power circuits, with a ground wire of 5/16 inch, 7 strand, copper clad wire of 30 per cent conductivity. A telephone circuit of No. 10 copper clad wire is run on a separate pole line, 35 feet from the center line of towers, with poles spaced 40 to the mile. Thomas suspension No. 1118 insulators, four in series, for suspension sets, and five in series for all strain sets, are used on power circuits.

COLUMBIA SUBSTATION.

A substation located in Columbia has been built, which will also act as a distributing station for the present hydro-

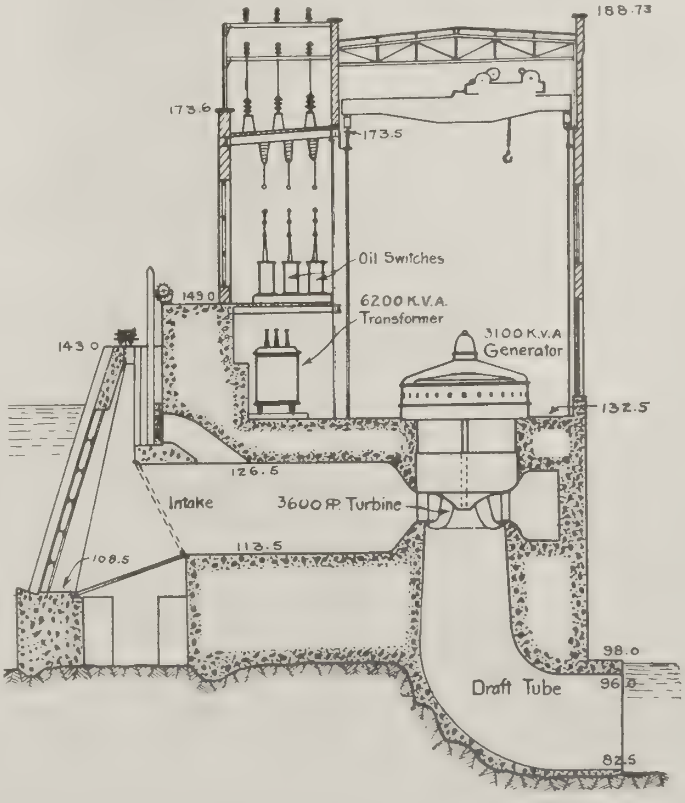


FIG. 6. SECTION THROUGH MAIN UNIT OF PARR SHOALS POWER HOUSE.

plant and steam plant of the Columbia Railway, Gas & Electric Company. All the power generated by these two plants and the plant at Parr Shoals will be distributed from this station. There will be two distributing voltages—13,000 volt, 40 cycle, 3 phase, and 3,400 volt, 40 cycle, 3 phase. The latter is the present distributing voltage and phase of the Columbia Railway, Gas & Electric Company. The building is of brick, with steel frame and concrete roof.

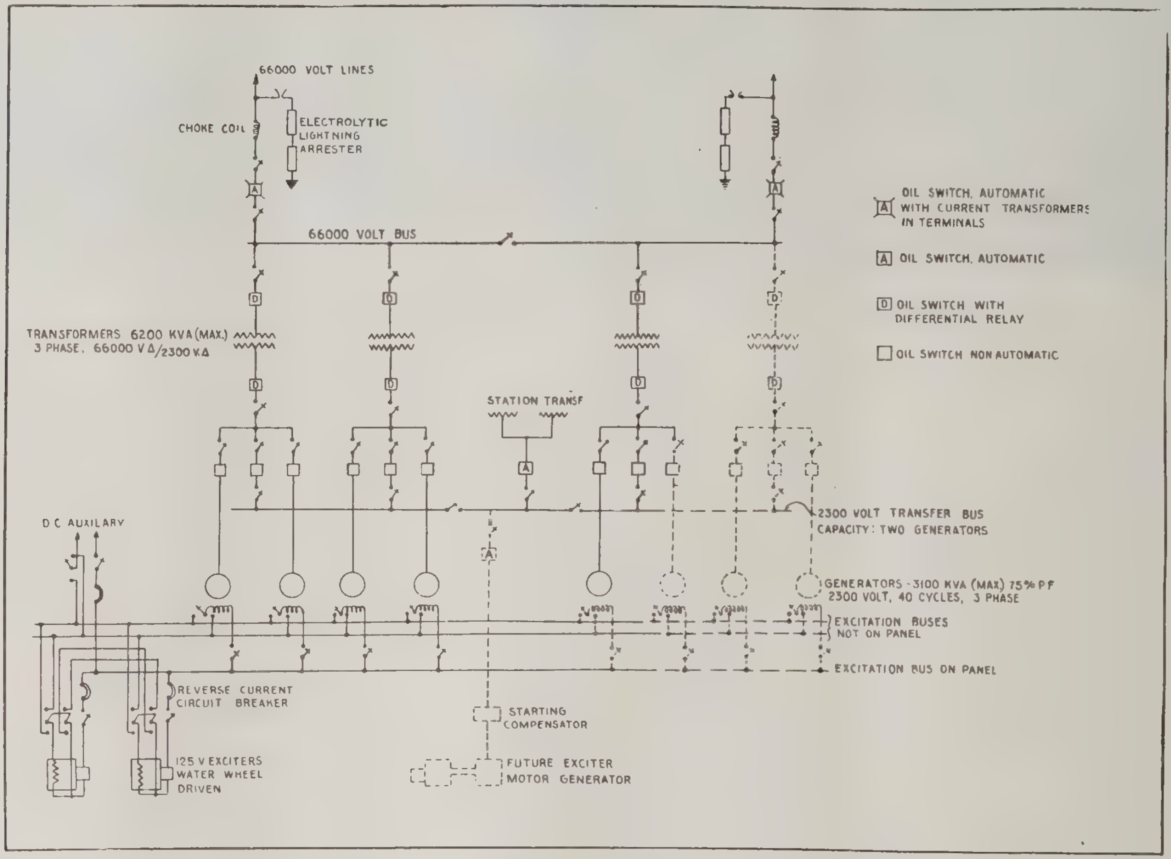

66000 VOLT LINES
CHOKE COIL
ELECTROLYTIC LIGHTNING ARRESTER
66000 VOLT BUS
TRANSFORMERS 6200 KVA (MAX.) 3 PHASE. 66000 V Δ/2300 V Δ
STATION TRANSF
D C AUXILARY
REVERSE CURRENT CIRCUIT BREAKER
125 V EXCITERS WATER WHEEL DRIVEN
STARTING COMPENSATOR
FUTURE EXCITER MOTOR GENERATOR
A
D
A OIL SWITCH, AUTOMATIC WITH CURRENT TRANSFORMERS IN TERMINALS
A OIL SWITCH, AUTOMATIC
D OIL SWITCH WITH DIFFERENTIAL RELAY
OIL SWITCH NON AUTOMATIC
2300 VOLT TRANSFER BUS CAPACITY: TWO GENERATORS
GENERATORS - 3100 KVA (MAX) 75% P F 2300 VOLT, 40 CYCLES, 3 PHASE
EXCITATION BUSES NOT ON PANEL
EXCITATION BUS ON PANEL

Fig. 7. Diagram of Circuits for Parr Choals Station.

The general scheme adopted in the construction of these plants has been, whenever possible, to start the various features of the work at such times as would bring their completion as nearly as possible to the date of delivering power. In this way one of the most expensive items—that of interest during construction—has been reduced to a minimum. Work on the substructure of the power house was started first. Then the sections of dam containing sluice gates and temporary openings, followed by the main dam, substation, transmission line, power house superstructure, and, finally, power house equipment.

The entire work of engineering and construction on both projects, except the raising of the Southern railway, is being handled by the J. G. White Engineering Company, of New York, and assistance in financing has also been given by them. Mr. E. W. Robertson, of Columbia, is president of the Parr Shoals Power Company, and Mr. J. H. Pardee, of New York, is president of the Georgia-Carolina Power Company.

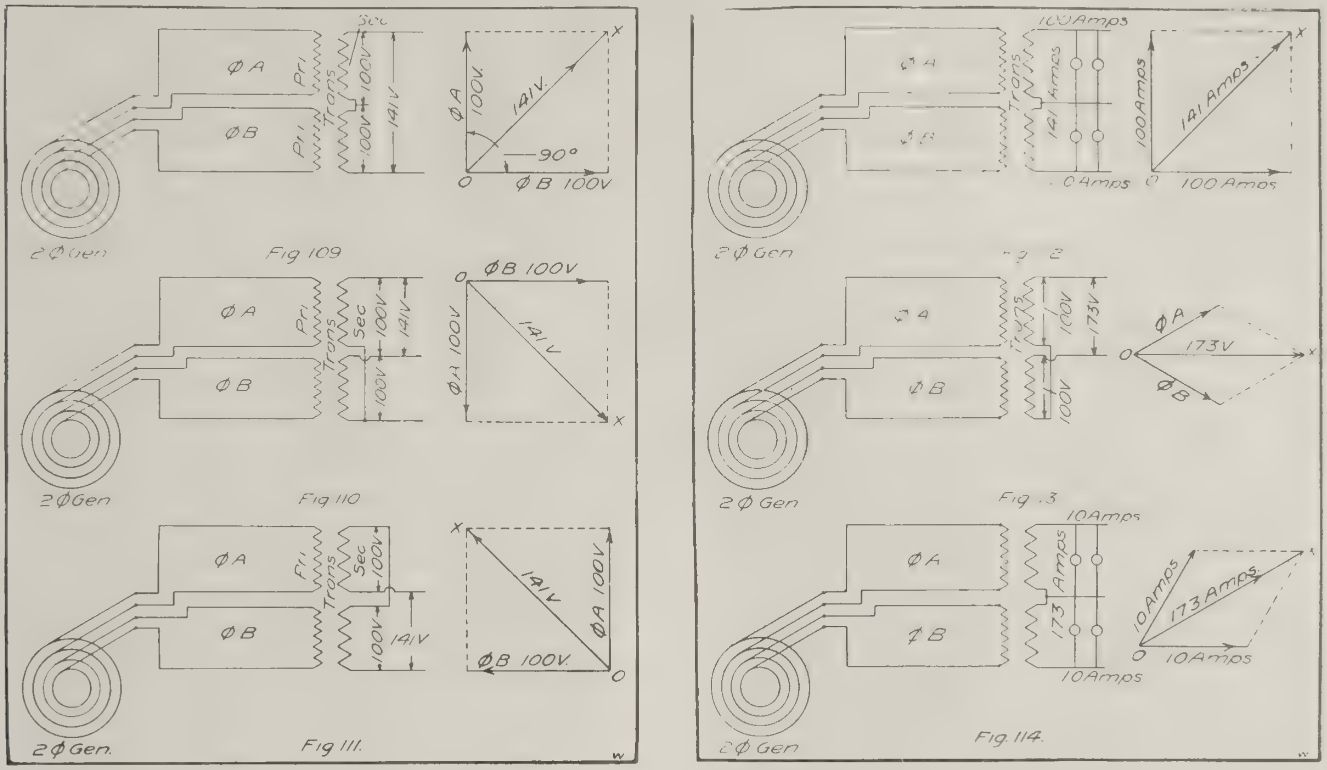
Alternating Current Engineering

BY WILLIAM R. BOWKER.

Section 18. Alternating Current Circuits and Systems—Vector Summation of Alternating Currents.

By vector summation we can obtain the resultant values of both amperes and volts, when dealing with polyphase circuits, in which the phase components have a phase difference or displacement. The latter is usually and conveniently measured in angular degrees. Take for instance, the case of a two-phase circuit as represented by Fig. 109, and connected to two transformers, in which the ratio of transformation between the primary and secondary circuits induces a voltage of 100 in each transformer secondary. If these two transformers are connected in series, the resultant voltage is not double the voltage of either one, but is less, due to the fact that the maximum emf's do not occur at the same instant, there being a phase difference or displacement of 90 degrees, the two-phase generator producing currents in quadrature. The numerical value of the resultant voltage will be determined by the phase displacement between the two component emf of phases *A* and *B* of 90 degrees difference.

A vector diagram as shown in Fig. 109, graphically solves the problem as to what the value of the resultant emf really is. Phase A is represented by a vertical line taken of such a length as to equal 100 units or volts. Phase B is represented by a line of exactly the same length (the voltages of A and B being equal), but drawn horizontally at right angles or 90 degrees to phase A, because the phase displacement is 90 degrees. Completing the rectangle as shown, and drawing the diagonal *O X*, it represents the resultant numerical value of the emf due to the component phases *A* and *B*, and this value is 141 units or volts or (100 × 1.41). It is to be observed that the resultant diagonal *O X* is 45 degrees behind phase *A*, and 45 degrees ahead of phase *B*. The numerical value 1.41 is the square root of two and is the value of a resultant when the components are 90 degrees apart and of equal numerical value. This ratio of 1.41 to 1 or $\sqrt{2}$ to 1 is an important factor in two-phase circuits.



Figs. 109 to 114. Vectorial Relations in Two-Phase Circuit Arrangements.

If one of the phase emf's be reversed, we obtain the resultant as shown in Fig. 110, in which the numerical value is the same as before, but the direction of the phase resultant *O X* has been altered in angular degree measurements, 90 degrees from its former position. The resultant *OX* is now 45 degrees behind phase *B* and 45 degrees in advance of phase *A*. If the direction of emf of phase *B* is reversed instead of that of phase *A*, we get the resultant as shown in Fig. 111. Applying the above principle to ampere values instead of volts, we arrive at results which tend to a very clear understanding of alternating current values due to phase displacement.

In Fig. 112 is illustrated diagramatically a two-phase circuit supplying energy to two transformers of equal voltage and capacity. The transformers are excited with two-phase current having a phase displacement of 90 degrees, the secondaries being so connected as to give a three-wire, two-phase system. The neutral will carry a current equal to the resultant as determined by the 90 degree phase difference. Its value can be obtained vectorialy, or by calculation, the result being 141 amperes, that is 100 times the square root of two ($\sqrt{2} \times 100$), the current being moved in phase relation to the two outer line currents midway or through an angle of 45 degrees. This arrangement constitutes a two-phase, three-wire polyphase system.

When the phase difference is not 90 degrees, and the component phases are of some other value as regards angular displacement, the resultant value is of a different magnitude. If the phases are 60 degrees apart, the resultant voltage is 173 as shown in Fig. 113, this being a ratio common in three-phase combinations and is as 1 to $\sqrt{3}$ or 1 to 1.73.

Applying the foregoing principle to the amperes obtained from two transformers of equal voltage and capacity, supplied with two-phase current that differs in phase by 60 degrees as shown in Fig. 114, the current in the middle wire will be 17.3 amperes if that in the outside wires is 10 amperes, the relation being as 1 to $\sqrt{3}$ or $1 \text{ to } 1.73 \times 10 =$ 17.3 amperes. If the two transformers were excited from two of the phases of a three-phase generator, with voltages 120 degrees apart, the resulting current in the middle wire would be of equal magnitude to the currents in the outside wires, but would be midway between them in phase.

In Fig. 115 is shown the windings of a two-phase generator, equipped with two independent windings so distributed and assembled that they produce a voltage with a phase difference of 90 degrees, the middle point of each winding being connected to a fifth or common neutral wire. This is known as the two-phase, five-wire system and is connected in star combination. The various numerical values of the voltages obtained from this combination are shown. Between wires 1 and 4 and 3 and 5 equals 200 volts, due to the phases being 180° apart and their combined effect added together. Between 1 and 5; 4 and 5; 3 and 4; 1 and 3 equals 141 volts, due to a phase difference of 90 degrees. Between 1 and 2; 2 and 3; 2 and 4; and 2 and 5 we get 100 volts, due to the effect of one phase only. On the same principle we obtain the voltages and amperes between and in the wires 1, 2, 3 and 4 as shown in Fig. 116, which represents a two-phase, four-wire polyphase delta connected circuit.

The voltages and amperes obtained as given are when the two-phase generator is equipped with four coils, assembled, distributed and connected so as to give a voltage at a phase difference of 90 degrees. While the phase current generated in each phase winding has a value of 10 amperes, each line wire receives or carries the combined currents due to two coils differing in phase by 90 degrees, thus giving a resultant of $10 \times \sqrt{2} = 10 \times 1.41 = 14.1$ amperes.

In Fig. 117 there is represented a three-phase, four-wire star connected polyphase circuit, showing the generator coils assembled and so connected that they generate and deliver energy at an angular displacement or phase difference of 120 degrees. The numerical value of the voltages and amperes resulting from the combination are also given.

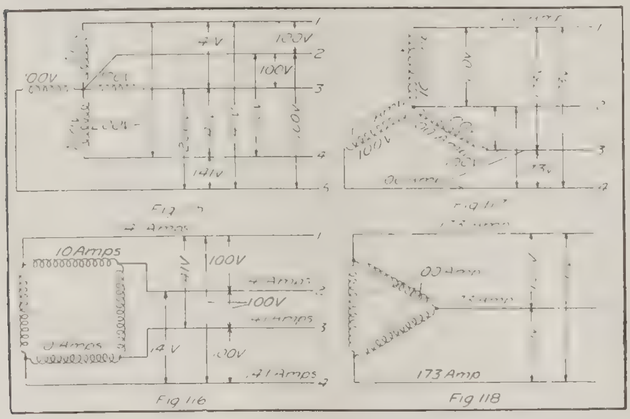


FIG. 115. TWO-PHASE, FIVE-WIRE SYSTEM, WITH STAR CONNECTIONS. FIG. 116. 2-PHASE, 4-WIRE, DELTA CONNECTIONS. FIG. 117. 3-PHASE, 4-WIRE, STAR CONNECTIONS. FIG. 118. 3-PHASE, 3-WIRE, DELTA CONNECTIONS.

The three generator phase wire terminals are connected to three line wires and from the common junction of the three coils, a fourth or neutral wire is connected so as to constitute four transmission lines. Assuming that each separate phase generates 100 amperes at 100 volts pressure, the voltage between each phase line wire terminal and the neutral will be 100 volts, while between the generator phase terminals and corresponding lines connected thereto, the voltage will be the resultant of the component voltages of two coils with a phase difference of 120 degrees, the numerical value of which is $100 \times \sqrt{3} = 100 \times 1.73 = 173$ volts, the current in each line wire being equal to the generator phase current of 100 amperes.

In Fig. 118 is shown a three-phase, three-wire delta connected polyphase circuit and assuming each of the generator coils to generate 100 amperes at a pressure of 100 volts in the phase circuits, due to a phase difference of 120 degrees, we get 100 volts between each pair of line wires, the same as across the phase winding terminals but the line amperes equal the resultant or combined currents of two component currents generated at a phase difference of 120 degrees, and while each phase current is 100 amperes, the numerical value of the line current is $100 \times \sqrt{3} = 100 \times 1.73 = 173$ amperes.

POLYPHASE TRANSMISSION AND DISTRIBUTION OF POWER.

In three-phase circuits, the generator coils may be connected either in star or delta, in which the star combination can have either three or four wires, the fourth forming a neutral junction to which the three ends of the generator three-phase coils are connected, the other free ends being connected to the three main transmission lines. Figs. 119 and 120 illustrate the two systems in which Fig. 119 shows the three-phase, three-wire, star connected circuit transmitting power to a three-phase motor and lighting feeders for incandescent lamps, which may be connected across one or two phases according to the voltage demanded by service requirements.

In Fig. 120 the three-phase, four-wire star combination is shown which affords a very convenient arrangement so as to obtain a variety of voltages. Three-phase motors of large capacity can be connected across the three-phase main power lines, while incandescent lamps and small single-phase motors can be connected between the neutral wire and each or either of the three main lines.

In three-phase arrangements when the generator is delta connected a 3-wire system is the result, although a delta connected generator may supply power through transformers that are star connected on the secondary side, as well as in delta. An alternative arrangement is to establish an artificial neutral point outside the generator terminals on a delta-connected system. The three-phase, threewire delta polyphase circuit is shown in Fig. 121, in which the three line wires may be connected to the motor windings either in delta or star. Single-phase small capacity motors may also be connected across any pair of wires.

The star winding of the polyphase generator as shown in Fig. 119 and 120 may be considered to be a series winding, when compared with the external circuit, while the delta generator winding approximates somewhat a parallel winding when considered with respect to the external circuit. The line voltage in the latter case is equal to the phase voltage, while in the star connected 3-phase generator, the line voltage is 1.73 times the phase voltage, the current in the line being equal to the phase amperes. In the delta connected 3-phase circuit, the currents in the outer lines are 1.73 times the phase amperes, being the vectorial sum of two currents generated at a phase difference of 120 degrees. To obtain the same pressure or voltage in the trans-

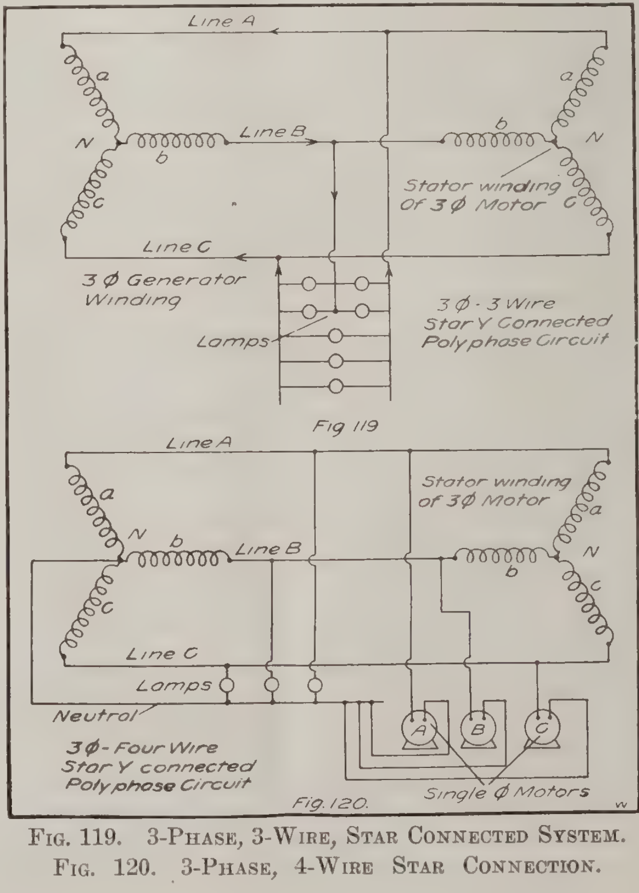

Line A
a
a
N
Line B
b
b
N
c
Stator winding Of 3∅ Motor
c
Line C
3∅ Generator Winding
Lamps
3∅ - 3 Wire Star Y Connected Polyphase Circuit
Fig 119
Line A
Stator winding of 3∅ Motor
a
a
N
b
Line B
N
b
c
c
Line C
Lamps
Neutral
A
B
C
3∅ - Four Wire Star Y connected Polyphase Circuit
Single ∅ Motors
Fig. 120.

FIG. 119. 3-PHASE, 3-WIRE, STAR CONNECTED SYSTEM. FIG. 120. 3-PHASE, 4-WIRE STAR CONNECTION.

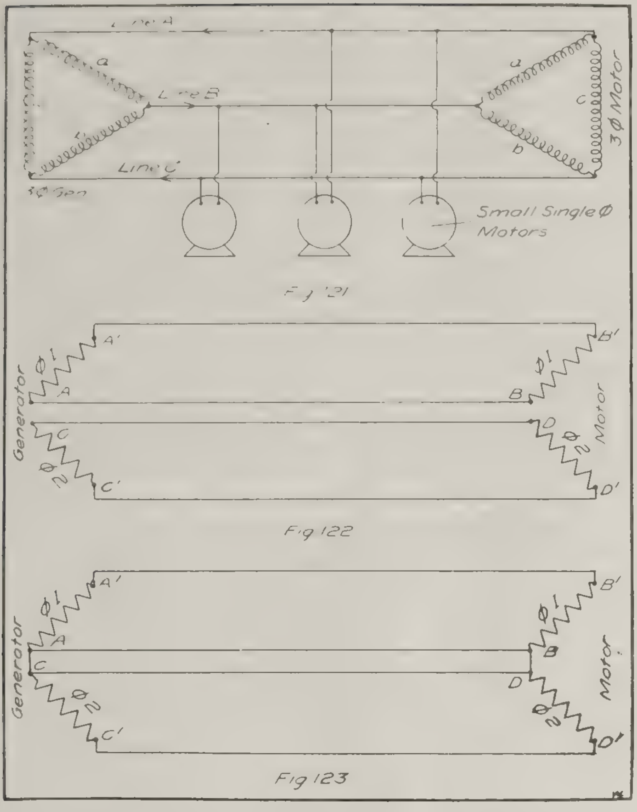


FIG. 121. 3-PHASE, 3-WIRE, DELTA CONNECTIONS. FIG. 122. 2-PHASE, 4-WIRE TRANSMISSION. FIG. 123. 2-PHASE 3-WIRE TRANSMISSION.

mission lines, with a delta winding, it requires about 73 per cent greater length of conductor in the three-phase generator coils than with the star grouping.

In Figs. 122 and 123, two-phase, four-wire and two-phase, three-wire combinations respectively are shown in which the generator phase and motor windings are represented with the transmission lines. In the two-phase, three-wire combination, the middle wire has to be of a larger area than either of the outside lines, having to carry the vectorial sum of two currents whose phase difference is 90 degrees, the resultant value of which is as $\sqrt{2}$ to 1 or 1.41 times the sectional area of either outside line.

The advantages of the three-phase system of distribution for lighting and power work is due to the fact that it can be economically used for long distance transmission. Thus a central station can do a large amount of business by supplying power to outlying factories, mills, etc., and in the supply to small lighting plants in widely distributed districts. Another practical advantage is that rotary converters can be operated. Also direct current for street railways can be supplied, and direct current for hoists, elevators, electrolytic work etc., can be supplied through rotary convertors receiving polyphase current. The disadvantage of the two-phase as compared with the three-phase, taking first the two-phase three-wire system, is that for a definite amount of power to be transmitted at a fixed pressure with a given percentage of loss, the amount of copper is considerably in excess of that required for the three-phase system under similar conditions. Moreover, the system on inductive load is very difficult to operate. The two-phase, four-wire system possesses similar disadvantages to the two-phase, three-wire as regards copper economy, but for transmission purposes only is fairly satisfactory; yet on inductive load is also difficult to operate.

It will be seen that such a system must be divided into groups or sets of groups. This division naturally overcomes many advantages and moreover, it becomes necessary to control each group by means of a. induction regulator, as the load factor of the various groups may be entirely different, depending upon the service requirements of the different districts into which the system runs. Consequently to keep constant pressure, the adjustments on each group, or branch of distributive service, requires careful attention.

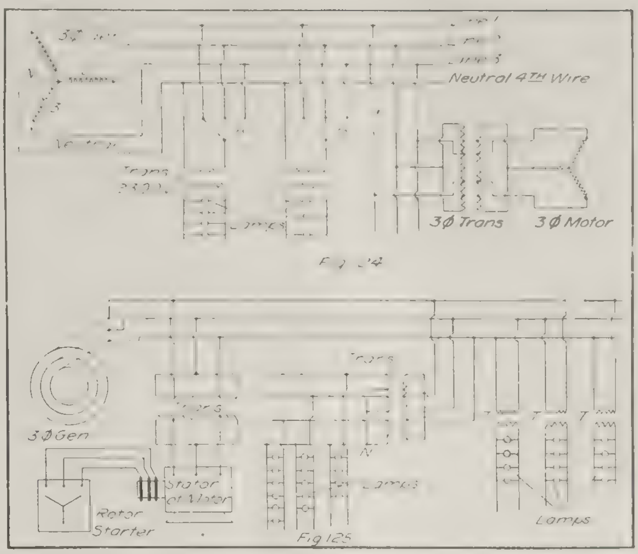


FIG. 124. 3-PHASE, 4-WIRE, STAR CONNECTION FOR POWER AND LIGHTING. FIG. 125. 3-PHASE, 3-WIRE SYSTEM. POWER AT LOW TENSION 3-WIRE AND LIGHTING AT 4-WIRE AND SINGLE-PHASE.

A three-phase generator is capable of taking 75 per cent of its rated capacity on one phase with normal heating, and this single-phase load is to all intents and purposes as great as that which could be carried by a machine of equal weight and cost, if it had been designed for single-phase work. If the generator is connected in star combination and is used as a single-phase machine, two-thirds of the windings are active, and the distribution of these active coils is practically the same as would be the case if the machine were designed for single-phase working.

In the three-phase system of distribution for lighting and power purposes as shown in Fig. 124, the generator is connected in star with a fourth wire taken from the neutral point *N*. In this system, the pressure between the lines is 4,000 volts, and between any line wire and neutral 2300 volts, the relation being as the $\sqrt{3}$ to 1 or 1.73 to 1.

From the station three-phase feeders, there is run a three-phase distribution net-work at a 4,000-volt pressure, which for lighting service requirements is transformed down to low-tension voltage by single-phase transformers, the leads to which constitute single-phase branch circuits, connected in between one of the three-phase main lines and the neutral. The transformer primaries are supplied with energy at a pressure of 2300 volts, the transformer secondaries delivering energy for lighting at the generally used pressure of 100 to 115 volts.

When motors are required to be operated, they may receive power from the three-phase mains through the intermediary of a three-phase transformer, which is a very good balancer. This system may be operated so that the motors have practically no detrimental effect upon the lighting. It will be seen that the lighting feeders can be switched on to either of the three line wires and neutral as shown at *A* and *B*. A high tension, three-phase, three-wire power

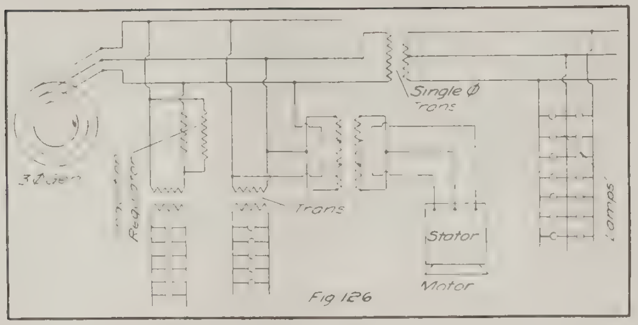


Fig. 126. Low Tension Distribution for Lighting at Single Phase, 3-Wire and Power for Motors at 3-Phase, 3-Wire.

transmission circuit, distributing power through the intermediary of transformers at low-tension as three-phase, three-wire for motors; and as low-tension, three-phase, four-wire for lighting is shown in Fig. 125. For power purposes, the transformer primaries and secondaries are connected in delta, the primaries being connected across the three line wires. For lighting requirements, the transformer primaries are connected across the three-phase lines in delta, while the transformer secondaries are connected in star combination. The neutral or fourth wire is connected to the common junction of the three-phase transformers, the lighting circuits being connected across one of the outside transformer secondary wires and the neutral, the circuits being balanced as closely as possible.

In Fig. 126 is shown a high-tension three-phase, three-wire transmission circuit, the energy for motor purposes being distributed as low pressure, three-phase, three-wire, through the intermediary of transformers whose primaries and secondaries are connected in delta, while the power for lighting is distributed as a single-phase, three-wire system taken from one side of a three-phase generator.

As already mentioned, polyphase systems possess great economical advantages and are utilized for long distance transmission of power and for distribution of power to motors and for lighting. Polyphase generators may be constructed more cheaply for a given output than single-phase generators for the reason that the armature winding space can be better utilized with reference to the distribution of the coils. Further, single-phase motors, except in small sizes, are not entirely satisfactory in practical service. Two-phase and three-phase systems are the only ones in general use for power transmission, three-phase being almost exclusively used for long distance transmission. Six-phase circuits are only used for rotary converters, the capacity of the machines being considerably augmented when connected six-phase.

The next section of this article will take up operating details of generating equipment.

Engineering Considerations in Connection with Passenger Elevator Systems

BY M. WILLIAM EHRLICH, CONSULTING ENGINEER, NEW YORK CITY.

Sections I. Elevator Development—New York Statistics—Safety Devices Explained—Hydraulic vs. Electric Machines—Relative Operating Costs.

THAT the modern type of office building is the accomplishment of engineering skill can hardly be disputed, for, besides the problem of proper foundations and the framing of the structure, an extensive electrical and mechanical equipment is always involved. Among the many important features of this composite structure, the elevator equipment is paramount. The requirement of tall office buildings in this respect is a very ample and adequate elevator service, not only because the monetary value of the building may otherwise be affected, but in time of necessity, as in time of a fire or other panic, the occupants may be readily brought to safety.

The object in view in presenting what follows is not to delve into the details of elevator construction or mechanical features, but to lay before those interested the results of a study in connection with the economic division of passenger elevators and an efficient elevator service for the traffic of the modern commercial or distinct type of office building. It becomes necessary, therefore, to briefly review the many considerations affecting this problem.

Over twenty-five years ago, New York witnessed the successful erection of the first steel-skeleton structure in the form of the ten-story Tower building on lower Broadway, which is now being razed to make room for a more modern enterprise. As a happy coincidence, the electric elevator also made its first appearance during the same year. Through these and other improvements the increased heights of buildings became a possibility, and in order to financially accommodate the constant rise in land values, with the accompanying increase in taxation at that period, office buildings of considerable heights were erected. During the early development the necessity for a proper elevator service was partly overlooked, and perhaps not altogether realized, for some of the older buildings suffer from a lack of traveling capacity, resulting in an inconvenience to the many occupants. The tenants of the upper floors are, therefore, obliged to wait on the up trip of the elevator, and the people occupying the lower portion of the building are left behind on the down trip.

A casual survey of present conditions on lower Manhattan may, therefore, not be out of place. Choosing thirty instances out of the many tall office buildings, including several more recent installations of elevator systems, it is found that these are supplied by a constant service of more than 400 passenger elevators, or 4 per cent of the total number in New York. The aggregate area of the buildings mentioned is a little under 10,000,000 square feet, with a total

Note.—This is the first of a series of articles by Mr. Ehrlich discussing the problems involved in providing adequate and economical elevator service in tall buildings. The second section will take up the elevator problem from the standpoint of the engineer, together with considerations for efficient operation. The remaining sections will take up installation data and power requirements.—Editor.

occupancy of 60,000 people. Under the above conditions this allows for a ratio of one elevator to 150 persons and about 165 square feet of floor space for each occupant.

The above does not fully indicate the extensive use to which the elevator has been adopted for passenger traffic. In the borough of Manhattan, including office, apartment and other types of buildings, with varying types of passenger elevators, the number in service aggregates 10,000 cars, or twice the number that were in service ten years ago. The writer estimates that these are divided among the different classes of buildings as follows:

5,000	elevators in office buildings over 10 stories in height.
1,500	elevators in office buildings under 10 stories in height.
500	elevators in loft buildings.
700	elevators in residences.
800	elevators in apartment houses.
500	elevators in department and other stores.
1,000	elevators in hotels, clubs, institutions, etc.

Considering the population as five million inhabitants, we find that there is practically one elevator serving a total of about 500 people. Besides the passenger cars, the building systems requiring freight service, involve an additional 10,000 machines. Thus, it is self-evident that the physical conditions in the metropolis as relating to elevators cause a general public concern, which becomes of especial interest to each occupant of a modern office building, and also affects the owners of such buildings. The individual interest centers, perhaps, on the safety of the elevator on account of its extensive use, sometimes many times in one day.

In modern elevator practice there are but two common types of successful machines in use—namely, the hydraulic and electric elevators. These may both be classified as to the mode of drive or operation and the transmission of power, thereby showing an apparent variety of elevators. The hydraulic type machine may be of the vertical cylinder pattern and also of the plunger type, while the electrical apparatus is either of the drum, worm-gear or gearless traction type.

The factors governing the choice and disposition of any form of elevator are mainly decided by the physical aspects and economic considerations given the building, and in general, as far as the advantages and disadvantages of one type of machine over another are concerned, no special merit can be claimed. Where the hydraulic type of elevator may show considerable advantage in one instance, the same points so considered may then prove a hindrance for another set of conditions. Even though a similar analysis may be made in connection with the electric type of elevator, it is a fact that this form of apparatus may be so arranged as to fulfill almost any conditions, and, on account of its qualities of acceleration and retardation, a greater traffic may be handled for the same car area.

The many accidents usually heard of are seldom, if ever, due directly to the faulty behavior of the elevator proper, but sometimes the breaking of suspension ropes, as recorded by a relatively few cases, will result in a serious accident. The greatest cause of the many accidents involved by the operation of elevators, and which may be avoided by proper safeguards, is that due directly to the negligence of the operator in handling the doors or elevator gates. So far as has been practically demonstrated, many of the safety appliances on the older installations designed to stop a falling elevator have usually failed to perform the functions allotted to them. But the improved wedge type of "jaw safety," actuated by a speed governor and attached to the more recent systems, usually will act when the elevator exceeds its normal running speed. Generally this occurs when the designed or safe-distance limit has been passed, and the jar occasioned by the final stopping of the car is not altogether a pleasant experience. The serious injuries and fatalities due to the falling of an elevator are proportionately small compared to the entire list, and amounts to about 20 per cent of the total, whereas the loss of life caused by open and unlocked gates in elevator practice today accounts for the remaining 80 per cent.

It may safely be said, therefore, that the only type of safety device that may be christened and properly called useful is that which would not permit the elevator to leave a landing until the gate has been locked. Among the several automatic devices now available for this provision of safety, all deserve merit; and while some are purely mechanical, others are actuated electrically, and only by the installation of such automatic locks will elevator accidents be reduced to a minimum.

A short historical account of the development of the commercial passenger elevator brings one back a little more than half a century to the introduction of the first "steam elevator." This form of drive was soon replaced by the "water-balance" type of hydraulic, which, even though a faster machine, proved to be, in operation, quite dangerous. For a number of years this type enjoyed the distinction of being the only high-speed apparatus until the advent of the vertical cylinder hydraulic about twenty years later. Running speeds as high as four hundred feet per minute were readily attained, and on account of the ease in handling and the safety in operation, these elevators soon gained favor and were the only types of machines installed in the then "tall buildings." The electric drum machine made its first appearance in New York during the year of 1889, and, owing to the merits of this new system, the electric machine soon established itself as a successful competitor to the hydraulic type. The only obstacle remaining was to overcome the slower speed, and this brought out the Sprague long-screw electric. Elevators of this type proved quite costly to maintain and operate, but on account of their possibilities of speed and high rise, were installed in several tall structures, including the present Park Row building. These different types of elevators did help considerably in the development of the "sky-scraper" buildings, and as further building projections brought on an extension in height, a hitherto unknown condition of passenger elevator service had to be met.

Only fifteen years ago the direct-acting plunger hydraulic elevator was introduced here to fulfill this increasing demand of continued high rise with high speed, and as the methods of installation kept the relative first cost down, it soon gained prominence. The inherent safety in operation and the relatively high economy would allow for no doubt as to the possibilities of the plunger, but through the progress of several years, experience pointed out that the many apparent advantages of the hydraulic plunger elevator were limited, and only under conditions of a rise not exceeding 150 feet could the characteristics of the safe and economical plunger elevator be maintained.

Less than ten years ago experiments were being conducted for the perfection of an electric elevator that would meet the growing requirements of heavy passenger traffic in the newest form of tall office buildings, and this resulted in the production of what is now commercially known as the "one-to-one" or gearless traction elevator. Among the earliest New York installations of this type of electric elevator may be named the Singer tower, and later the Metropolitan, whereas the latest developments include the Woolworth and new municipal buildings.

In summarizing, it might be well to mention that the commercial or useful life of an elevator and its combined mechanisms seldom exceeds fifteen years, and that where remodeling has been resorted to the electric drum and worm-gear traction has usually been substituted for the hydraulic type in buildings not exceeding twelve to sixteen stories, and in higher structures the gearless traction or its modification in the form of an electric "two-to-one" traction elevator has been resorted to. If the theory of the "survival of the fittest" may be mentioned, it is true that the electric elevator has now come to its own. Another point that may be mentioned for the skeptics, and also for the firm adherents of the hydraulic elevator, is the fact that the one or two manufacturers who used to specialize in the manufacture of the hynraulic elevators have now turned their efforts to the selling of the electric type of machine. This is also true of the many manufacturers who turn out both hydraulic and electric elevators, for they now seldom suggest the hydraulic, but will almost, without exception, solicit for the modern electric machine.

It is true, though, that both the electric and hydraulic types of elevators have been perfected to a state of high efficiency, and they may, therefore, be used with entire safety. Of the hydraulic types it may be said that the plunger elevators do possess a certain natural safety not to be found in the suspended form, or even in the more modern electric traction elevator, but it cannot be denied that the many refinements and improved appliances recently attached to the various electric types of machines as illustrated in Fig. 1 have certainly placed them on a par for reliability with the best form of hydraulic practice. This is especially true of the electric traction elevator, which possesses a certain inherent safety owing to the improved methods of power transmission and the peculiar form of windings used for the drive.

In narrowing down the question as to the merits of the electric traction elevator and the hydraulic plunger elevator for passenger service in tall office buildings of today, it might be well to note that all the new elevator installations, almost without exception, have favored the electric. Not only is the cost of installing the traction 25 per cent to 35 per cent less than the plunger type, but the room occupied by the driving machinery is reduced to a minimum, and, as a matter of fact, may be placed at the head and directly over the elevator shaft. If no local supply of electricity is available on the premises, the public source may be resorted to.

The difficulty with the plunger elevator for high-rise, high-speed work lies in the requirement for moving the mass of water and the massive plunger proper, and as this immense weight cannot be readily and smoothly stopped, the result is a sluggishness in starting and stopping. At any rate, it remains an open question as to whether the economic values attached to modern buildings would favor the installation of the plunger elevator, with its accompanying pumping plant, which necessarily occupies considerable

Relative Operating Costs of Elevators.

COSTS	OFFICE BUILDING				LOFT BUILDING				APARTMENT HOUSE			
	Traction Electric	Electric Worm-Gear	Vertical Cylinder Hydraulic	Direct Plunger	Electric Traction	Electric Worm-Gear	Vertical Cylinder Hydraulic	Plunger	Electric Traction	Electric Worm-Gear	Vertical Cylinder	Hydraulic Plunger
Per Cent of Rentals............	8.5	7.2	6.8	6.5	8.0	6.8	6.5	6.2	6.8	6.0	5.5	5.3
Cents Per Car Mile..............	25	22	20	19	23.8	20	19	18	20	18	17	16
Dollars Per Car Mile Per Annum	$2100	$1850	$1680	$1600	$1075	$900	$860	$810	$560	$510	$480	$450
Per Cent of All Operating Costs.	14.1	12.0	11.3	11.0	18.0	15.4	14.8	14.0	13.6	12.0	11.0	10.6

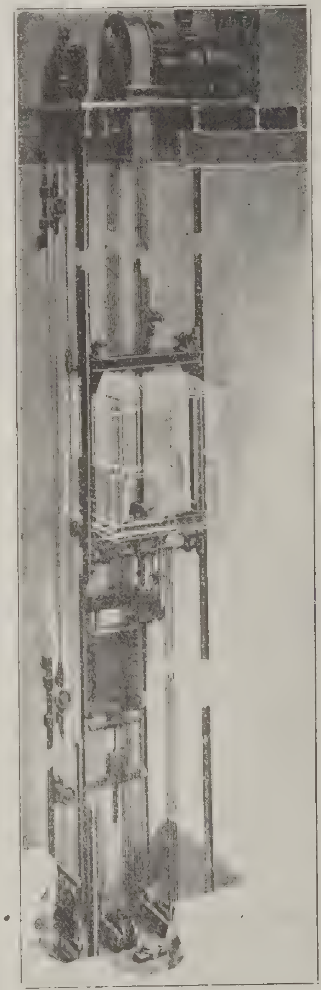


Fig. 1. An Electric Traction Elevator Equipment, Showing Safety Devices.

floor space. The only open choice, therefore, would tend to favor the high-rise, high-speed electric traction elevator for passenger service.

The figures given in Table I may prove of interest in pointing out the relatively higher operating costs of the different electric types over the vertical cylinder hydraulic and plunger elevators. The values given represent only the cost of labor, power, repairs and supplies. By a close perusal of the amounts listed, it will be confirmed that the economies of the plunger cannot be utilized beneficially in tall office buildings on account of the mechanical difficulties, and in other types of smaller buildings allowing for a low rise, the installation cost becomes exorbitant. If the relatively high first cost of this type of machine were taken into consideration, with an addition for the extra cost in building construction necessary for the space occupied by the pump and tank equipment, the total expenditure on the whole would show no great favor either way.

In explaining the values given in the tabulation, it should be understood that the figures are computed on a basis of actual records of several buildings that have come to the writer's notice. The general method of comparing records in business buildings is to relate the costs to the total annual income or rental. The total operating costs include the expense in the mechanical, electrical and building departments, covering all costs of labor and material for the maintenance of the different divisions of service. Therefore the annual cost of operating an elevator system is given as a percentage of the gross rentals received, and is further stated as a percentage of the total operating expenditure of the buildings under consideration. The average cost in cents per car mile traversed is also given, together with the average annual cost in dollars to pay for the labor in operating and repairing, the necessary power, and the material and supplies required per single elevator.

The Design of Steam Power Plants

BY EARL F. SCOTT, M. E., MEMBER A. S. M. E.

Section 9. Water Supply Arrangements—Air Lifts. Condenser Considerations and Boiler Room Economies.

In what follows the design of a combination power station and ice plant will be continued from the section appearing in the February issue of *Electrical Engineering.* The nature of water supply for this plant will be now taken up, discussing the purchase of water from city mains and the use of deep wells. In the average town or city, water for manufacturing purposes can be secured at a price not to exceed 10 cents per 1,000 gallons. It has already been determined that the water losses are from three sources, as follows: By evaporation, about 18,000 pounds per hour; from drifts from the spray pond, about 1 per cent of the total circulating water; and from sun evaporation, a loss difficult to estimate and regulated by local conditions.

From previous calculation it has been found that 1,422 gallons of circulating water will be required per minute. The loss from evaporation is then $(18{,}000 \times .002) \div 1422 = 1.5$ per cent, or 36 gallons per minute. The loss of 1 per cent due to drifts, etc., equals about 14 gallons per minutes, making a total loss of 50 gallons per minute to be either pumped or purchased from the city. If this water is purchased, the cost of same will be $(50 \times 60 \times 24 \times 30 \times .10) \div 1000 = \$216.00$ per month, which seems rather high and prohibitive.

If water is to be secured from deep wells, it must be pumped, and the use of air lifts for this purpose comes up, since such a means is used to a considerable extent throughout the South. In this connection it is necessary to know the height at which the water stands below the surface of the ground and the distance this height will be increased when pumping a given quantity of water from the well. Since these are natural conditions and vary with every deep well, a general formulae can be derived from which the amount of air required and the pressure of the air necessary to raise a given amount of water from a well can be determined. The accompanying sketch, Fig. 1, shows the general scheme on which an air lift is based, and the following data applies to same:

To determine the point where the nozzle is to be placed, divide A by four-tenths. This means that the lift is considered 40 per cent efficient. From the sketch it is seen that the result of $A \div .4$ gives the length of the air pipe from the discharge to the bottom. To determine the air pressure necessary to start the lift, multiply B by .433, in which B is in feet and the result in pounds. To get the volume of air required to raise one cubic foot of water ($7\frac{1}{2}$ gallons), divide the air pressure by 14.7 pounds and add 1. That is, cubic foot of air per cubic foot of water $= (P/a + 1)$. Where, P is air pressure (gauge) plus 14.7; a atmospheric pressure or 14.7 pounds; with "one" representing one atmosphere. b equals .6 A, and P equals .43 b.

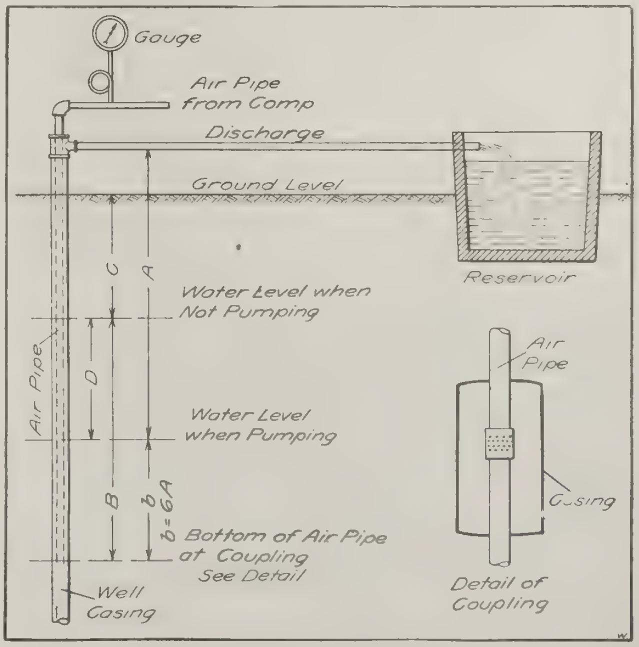


Fig. 1. Diagram Showing Features of an Air Water Lift.

Where b is the distance of the nozzle from the water level during pumping.

It is observed that the above data is empirical, and that measurements must be taken at the well in order to determine the working conditions. For illustration purposes, the following water elevations will be assumed and the amount of air determined that will lift the quantity of water required as specified above. This quantity of water is 50 gallons per minute, or 6.7 cubic feet per minute.

According to the formula already given, C will be taken as 60 feet, D as 65 feet, and A as 70 feet. Then $b = .6 \times 70 = 42$ ft. and $P = .433 \times 42 = 18.18$ pounds. Also $(P/a + 1) = [(18.18 + 14.7)/14.7] + 1 = 2.24 + 1 = 3.24$ cubic feet of air per cubic foot of water. Then $3.24 \times 6.7 = 21.7$ cubic feet of air at 18.8 pounds pressure (gauge) required to pump 50 gallons of water per minute under the conditions named. The writer has used these empirical formulae for lift work in connection with deep wells in the Louisiana fields and secured very good results, although they are more or less approximate.

In Fig. 1 an enlarged view of the lower portion of an air nozzle suitable for use in this connection is presented. At about 6 feet from the bottom of the air pipe a coupling is placed, perforated with holes equal to about .75 of the area of the air pipe. Below this coupling about 6 feet of open, straight pipe continues to the bottom of the well. This additional piece of pipe forces the air out through the holes in the coupling, the open end of the pipe allowing a vent for the air if the pressure rises. On tests, this type of nozzle has shown as good efficiency as claimed by some of the more extensive and patented air lifts.

The size of air compressor required will be as follows: Since 21.7 cubic feet of air at 18.18 pounds is required, or 21.7 cubic feet at $[(18.18 + 14.7) / 14.7] = 2.24$ atmospheres, then $21.7 : X = 1 : 2.24$ where X equals 48.5 cubic feet of free air required. A 10 x 10 inch air end compressor running at 80 feet per minute would be large enough for this service. The work necessary to raise the water required a given height is determined as follows: $(50 \times 8.33 \times 70) \div .30 \times 33000 = 3.0$ Php. This represents the work required, but does not take into account the efficiency of air compressor or motor, which would be about 85 per cent for compressor and 90 per cent for motor. Then $3 \div (.85 \times .90) = 6.6$ Hp. for the motor. With cost of current at 1.5 cents per Kw.-hr., the operation of the motor would cost about 7½ cents per hour, making the air compressor operation total $7.5 \times 24 \times 30 = \$54.00$ per month, against $216.00 when purchasing water from the city mains. In these figures, however, no consideration has been given interest on the money required for sinking wells and cost of compressor plus depreciation on same.

In this connection it is necessary to consider the water supply for ammonia condensers for the ice plant, which is a part of the plant under consideration. The water conditions already taken up are for the turbine condenser, so that an additional amount will be required for the ammonia condenser. For steam condenser purposes, water to the condenser at 80 degrees can be used; but for the ammonia condenser, water at this temperature requires high head pressures on the ammonia condenser as well as a large amount of water to be circulated over the condenser. In order to determine how much heat must be dissipated per ton of ice made, we will assume that the distilled water has been cooled to 60 degrees after leaving the boilers, and that ice is being frozen down to 17 degrees. In one ton of ice, then, there are $60 - 17 = (43 + 142 \text{ latent}) \times 2000 = 370{,}000$ B.t.u. Assuming 42 hours as the time for freezing, $370{,}000 \div 42 = 9{,}000$ B.t.u. per hour, or 150 B.t.u. per minute.

Assume a head pressure of 180 pounds gauge. The temperature of the ammonia at 180 pounds equals 94 degrees F. Since for ammonia we will have to use iron pipes for all cooling mediums, we cannot expect to approach the temperature of the ammonia in the coils by several degrees, say 5 degrees. If well water is used at 60 degrees, 1 pound of water will absorb $94 - (5 + 60) = 29$ degrees or B.t.u. Since we must dissipate 150 B.tu. per minute, we will require $150/29 = 5.2$ pounds of water per ton of ice made per minute, or .63 gallons per minute. With water at 80 degrees and the same head pressure, we would require 2 gallons per minute. For the steam condensers 50 gallons of water per minute are required. With well water at a temperature of 60 degrees, it is found from the above calculations that $.63 \times 50$ (tons) $= 31.5$ gallons per minute are required for ice making or for the ammonia condensers. We may, therefore, run the water over the ammonia condenser direct from the well, which raises the water temperature to about 90 degrees. This water can then be pumped through spray nozzles and cooled down to about 80 degrees for use in the steam condensers. Since the loss from evaporation is 50 gallons per minute, the water secured from the well can be such a quantity as to make up a balance in the loss of water. This combination saves the pumping of water from wells for one process and cuts the expense in half.

In the above consideration the medium required for reducing the reboiled water from 212 down to 60 degrees has not been considered. It may be found that this can be done by allowing the return ammonia to pass through the coils cooling this water and still not affect the efficiency. If the ammonia gas is expanded to a pressure of 19.46 pounds gauge, it assumes a temperature of 5 degrees above zero, and this gas passes through the coils in the brine circulation and absorbs the heat from same, continually rising in temperature and pressure until it is not practicable to carry it further. Since there is such a great difference in the reboiling water temperature at, say, 212 to 60 degrees, by passing this same ammonia through it we may absorb the heat from the water and raise the ammonia pressure on its return to the compressor for a second cycle. In this way we will not require any water for this purpose. This completes the water consideration necessary for the plant, and attention will be turned to the remainder of the auxiliary machinery.

A surface condenser of 2,600 square feet has already been selected for a 7,500 Kw. turbine, and for the 500 Kw. machine one of two-thirds this size, or 1,750 square feet, is required. Since only one turbine will be in operation at any time, we may connect the two machines to the same condenser, and in this way save the expense of one condenser, less the increased cost brought about by additional piping. In this event, however, a larger size of condenser will be required.

In connection with the surface condenser, a circulating pump and an air pump will be required. These pumps may be steam or electrically driven, and may be centrifugal or reciprocating. They may be driven from the same shaft or separately. In regard to the question of steam and electric drive, it has already been determined in a previous design that only enough steam is available from the boiler feed pumps to raise the feed water temperature about 15 degrees. Since this is true in most cases, it is imperative that we drive one or both of these machines by steam. In all probability we will have sufficient steam from the circulating pump driven by a non-condensing steam turbine which will permit the operation of an air pump by a motor.

To check this assumption, we may consider for average conditions that the water from the condenser discharge will be 90 degrees, and that the boiler feed pumps will raise this temperature 15 degrees, or to say 105 degrees. Therefore the boiler will be required to handle 18,000 pounds of water per hour from 105 degrees to 210 degrees or supply (210 — 105) × 18,000 = 151,000 B.t.u. per hour. The size of the circulating pump, as already determined in the last section, is 6.65 Php., which, reduced to Ihp., and considering the efficiency of pump 60 per cent and that of turbine 95 per cent, will be 11.5 Ihp. This turbine will operate at about 45 pounds per Ihp.-hr., and will furnish exhaust steam equal to 11.5 × 45 = 517 lbs. Each pound of this steam will contain 965 B.t.u., and will thus make available 517 × 965 = 498,905 B.t.u., which is ample to raise the temperature, as mentioned above.

It is worthy of mention that the circulating pump can be driven by a motor and the air pump by a small turbine. The advantage of driving a circulating pump by a steam turbine, however, lies in the fact that this pump can be driven independently from the main turbine, thus allowing the starting of the auxiliary machinery before starting the main turbine, and thus start up the main turbine, condensing instead of non-condensing. If a centrifugal dry vacuum pump is used, it may be connected direct to the shaft of the turbine, but this is a detail which can best be determined by comparative prices and should be determined on this basis.

Since this is the first plant for which a surface condenser has been specified, and inasmuch as a specification for this type of condenser has not been written in our previous designs, the following will cover same:

SPECIFICATION FOR SURFACE CONDENSER AND AUXILIARY MACHINERY.

Type.—The condenser shall be of the surface type, horizontal pattern, with the cooling medium made of brass tubes ½ or ⅝ inch inside diameter.

Capacity.—The condenser shall have a sufficient cooling surface to condense 16,500 pounds of steam per hour and maintain a vacuum of 27 inches (Barometer 30 inches) when furnished with sufficient cooling water having an initial temperature of 80 degrees F.

Material.—The condenser shell and heads shall be close grain, soft, gray iron, free from flaws, and shall have proper sized openings for the exhaust (size turbine exhaust outlet) water and air connections, with these connections so placed that the pipe connections will not be broken in getting to the tubes for cleaning or repairs.

Tube Heads and Tubes.—The tube heads shall be of bronze heavy enough to allow for expanding at one end and for a stuffing box at the other. Tubes shall be of cold drawn brass, either ½ or ⅝ inch inside diameter. One end shall be rolled into the bronze head, and the other to protrude through the head far enough so that expansion and contraction will not cause the tube to cut the packing. Provision shall be made so that a gland and stuffing box shall be provided at this end, packed with corset lacing or similar good packing. The tubes shall be arranged so that the steam flow on the outside and the water circulates through the tube.

Baffles.—At the entrance of the condenser a baffle plate shall be arranged to force the steam to spread over the tube surface. The water inlet shall be so arranged that the water cannot bypass through a few tubes. The arrangement shall be provided so that the coldest water will come in contact with the coldest steam or that the steam inlet and water outlet tubes shall meet.

Circulating Pump.—A steam-driven turbine centrifugal pump of sufficient capacity to deliver the proper amount of water for producing the vacuum mentioned above, shall be provided when the water is at a temperature of 80 degrees F. This pump must operate against a head sufficient to overcome the friction in the condenser and give a static head of 5 pounds at the nozzle of the spray. The suction head on the pump will be zero, and there will be an equivalent of 4-ells and 60 feet of pipe in the discharge line.

Air Pump.—The shaft of the centrifugal pump shall be extended, and an air pump of sufficient capacity shall be mounted on the same base and shaft, to produce and maintain a vacuum already mentioned. A drawing must be furnished showing the proposed arrangement of condensers, pumps, etc., with a complete specification giving in full the details of all apparatus, including characteristics of the centrifugal pump and steam turbine.

The boiler room machinery will now be considered. Since the plant under discussion is similar to the one taken up in the preceding design, and too small for a turbine boiler feed pump, we will select the same style of pump as in the preceding case and in the same manner. In regard to feed water heaters, we have a choice between an open and a closed heater, the advantages and disadvantages of each having already been discussed in connection with the designs of plants presented in previous sections of this article. In this particular installation we will use the exhaust from the condenser circulating pump turbine, and as this exhaust is in excess of the amount required, we will permit the boiler feed pump to exhaust to atmosphere, and thus not have oil to contend with in the feed water heater. On this account there is no argument in favor of the use of the closed heater, since the open type has all the advantages of the closed and many others in addition, such as raising the water higher than in the closed type. We will, therefore, select the open type of heater. A specification for this heater will not be prepared, since the general features of same will be similar to specifications prepared for plants in the designs already presented.

This completes the selection of the boiler plant equipment. There are, however, some smaller items which deserve attention, such as recording instruments, water regulators, grates for boilers, etc. Since coal is the most expensive item in power plant operation, the possible saving through properly operating a boiler is worthy of consideration. A plant of this size is usually considered too small for the installation of stokers, for, unfortunately, most engineers believe that the small plant does not require labor-saving devices in order to properly utilize heat units after being purchased in the form of coal. As a general proposition, mistakes are most often made in this direction, and on this account a consideration will be taken up here of the plain herringbone grates and a modern rocking grate.

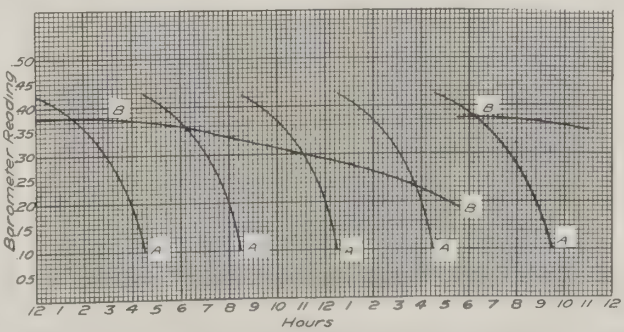


Fig. 2. Diagram Showing Economical Draft Zone for Boiler Operation.

The illustration presented here emphasizes the fact that there is an economical zone between maximum draft and no draft where a draft gauge should stand at all times. This zone may vary slightly, but boiler operation proves most satisfactory when it stands between .30 or .40 inches. The curves *A A* in Fig. 2 represent draft with a plain grate, and show that about every three or four hours fires must be cleaned in order to get the draft back to the economical zone, when it will again drop after a similar period of time. In this process there are losses through shaking unburned coal through the grates at each cleaning, and a loss from allowing cold air to rush through the fire and cool down the furnace. At each cleaning of the fires a loss of from 25 to 40 cents takes place on account of these features, and with about four cleanings per day the total loss for any installation can be readily calculated.

With a rocking grate, the draft performance is shown by curve *B*, which is practically a straight line located well within the economical zone, for six to ten hours after which it drops gradually, and eventually falls to a point where the grates must be given a thorough shaking. When this takes place, however, the draft doors are not open and cold air is not permitted to rush in. The unburned coal is not lost, since the shaking stops at the time fire begins to drop in the ash pit. The fires after this treatment are then ready for another long run. With a good rocking grate, one and a half to two shakings per twenty-four hours is good practice. The saving due to a shaking grate can be conservatively estimated at 10 per cent of coal and an increased rating in boiler of 10 per cent. With a close watch on the conditions of the flue gases by the use of a CO_2 recorder or gas analyzer, practically smokeless operation of furnaces can be brought about. A further check on operation of the boiler plant can be secured by the installation of recording draft gauges, steam gauges, steam flow meters, etc., to check up the efficiency of the boiler plant operatives.

Important Considerations When Ordering Power Transformers

BY H. G. DAVIS, E. E.

Section 6. A Discussion of Transformer Losses.

To determine the value of transformer losses we must know approximately the cost of power to the customer or the cost of producing power. Knowing this we can calculate the value of a given kilowatt loss in copper or iron from the expense entailed to supply this loss. We have thus to consider the cost of producing power. This can be divided into three parts: (A) Fixed charges independent of station capacity and output. (B) Capital charge which is proportional to the kilowatt capacity of the station. (C) Output charge which is proportional to the kilowatt hour output of the station. The fixed charges are not affected by losses so that will not be considered. However, the charges under (B) and (C) will be affected and the ability to determine the relative values of losses by the charges which they will produce will bring about greater economy in ordering.

In considering the value of losses on a system with transformers, we have two kinds of losses to be considered—losses due to copper and losses due to iron. The expenses involved may be considered as follows for these losses:

Copper loss and regulation: (A) Energy loss in transformer itself. (B) Additional station capacity required to take care of energy loss. (C) Varying voltage due to regulation and its attendant evils such as dissatisfaction among customers and shortening of life of lamps.

Iron loss and magnetizing current: (A) Energy loss in transformer itself. (B) Additional station and line capacity required to take care of this loss.

COPPER LOSS AND REGULATION.

From the nature of copper loss we see that it occurs under load only. This loss should be considered as so many hours per day at full load. Since this loss comes at a time when the transformers are carrying load and the generating apparatus is fully loaded, its cost is of the nature of a peak load and the generating capacity to take care of this loss is of the nature of a stand-by for use at full station capacity. Thus the cost of copper loss increases with the duration of maximum load and thus with the load factor of the station. As transformers are not always under full load at the same time, the full load copper losses will require less than that amount in capacity at the station. The rated station capacity required will be in the same proportion to the rated copper loss as the peak station capacity is to the connected transformer capacity. The capital charge per kilowatt loss will be the capital charge per kilowatt capacity multiplied by this ratio.

By formula for the regulation, we have seen that at unity power factor it is the same per cent as the copper loss. At lower power factors the regulation increases so that it is a greater per cent change in voltage than the copper loss is decrease in efficiency. Thus the change in voltage due to regulation of the transformer increases rapidly with poorer power factors under load especially if motors are being supplied. This poor regulation when it is as much as 3 per cent may become objectionable to lighting consumers with all its resultant complaints and loss of consumers. For lighting 2 per cent regulation is usually desired and imperative for lighting with carbon lamps without complaints. The tungsten lamps will stand a greater variation in voltage for a given variation of candle-power. The quality of light does not change in tungsten lamps for variation of voltage as is noticed in carbon lamps. Further, the life of the carbon incandescent lamp is shortened by fluctuating voltage and the cost of a given amount of light at a constant voltage will be less than the cost of the same amount of light operated on a fluctuating voltage having the same mean value. This means that lamp renewals will be greater for fluctuating voltages or poor regulation. This cost of renewals is of importance compared with copper loss unless the transformer has very low regulation.

The consideration of varying voltage will apply to drop in lines as well as to regulation in transformers, but the fact remains that regulation becomes effective when the transformers are loaded and the losses in the copper feeders are greatest. Thus regulation becomes more important and must be considered in connection with the drop in voltage under load due to line loss.

In connection with the contention that regulation causes loss in revenue by causing loss in power sold, we can say that regulation is fluctuation and central station practice makes the fluctuations as equal as possible, above and below the desired voltage. Since the average of the fluctuations is the desired voltage, there can be no power loss under that which would be sold if the voltage were absolutely constant at the desired voltage which is the mean of the fluctuations. Thus the regulation should be such and the no load voltage such that the voltage which is correct or desired at the consumer is the mean between no load and full load on the transformer.

IRON LOSS AND MAGNETIZING CURRENT.

Unlike copper loss, iron loss is continuous and exists at all times when voltage is impressed on the transformer. The cost of this loss will be the cost of the apparatus to generate the iron loss and the cost of generating the losses themselves. Also the cost of transmitting the losses and the magnetizing current will enter in. The iron loss requires a continuous supply of energy at low power factor varying from 10 to 30 per cent. This low power factor means that the kilo-volt-ampere generator capacity required is much larger than the actual kilowatts delivered. With this low power factor the losses in the generator increase very rapidly due to the copper and iron loss of the generator itself. The Kva. capacity of the generator required to deliver a given amount of energy for various power factors is 1.00 at P. F. = 1.00, 1.25 at .8 P. F.; 1.66 at .6 P. F. and 3.33 at .3 P. F. Thus for a given iron loss but varying power factors, the generator capacity increases very rapidly as the power factor decreases With decreasing power factor and increasing current, the line losses due to exciting current increase rapidly. The increased losses in line and generator require an increase of power from the prime movers and are thus objectionable. However, power factor of the exciting current is objectionable only from the standpoint of increased current for a given iron loss. For a given current the decrease in power factor for decreased iron loss is not objectionable. Power factor of the exciting current should be considered only in connection with the iron loss itself.

The fact that iron loss is continuous means that generating capacity much beyond the required power must be kept in operation to supply this loss at a low power factor. The running light losses of this generating equipment may be 10 per cent of the full load loss while the iron loss supplied may be at a P. F. of 20 per cent or the generating equipment may be delivering 20 per cent of full load Kw. at full Kva. capacity. Thus 20 per cent iron loss has entailed 10 per cent additional loss due to the fact that this energy has to be supplied at a low power factor. Thus iron loss multiplies itself at the station by requiring the additional capacity to be in operation. This applies chiefly to systems that have full load for a short time only where the ratio of peak capacity of station required to connect transformer capacity is low.

Where the load factor of the system is good and where the peak station capacity required is a large proportion of the connected transformer capacity, the loss caused by magnetizing current in line and generator decreases due to the line current of the load itself. The loss will depend on the magnitude of the line current. Magnetizing current does increase the line current and continues at no load and at peak load. Thus the capacity at the station must be increased and hence the cost of supplying magnetizing current as well as the true iron loss can be figured.

The general considerations as given above must be taken into account in order to get the most desirable transformer for a given condition. The engineer must know the conditions under which the station is to operate and the relative cost of the losses, etc. This can be determined from the conditions of the system and each case will require its own adaptation, for cost of generation and capital charges always differ depending on the system. Also the load factor and hence the ratio of duration of peak loads vary. Thus the proportion of the elements of loss (copper and iron) depend on the system.

In general in choosing a transformer, the choice should be such that the total cost of the transformer is a minimum. This means that the first cost of the transformer together with the cost of the losses should be a minimum. In order for the cost of the losses to be a minimum the transformer should be operated with a ratio of copper loss to iron loss which is determined by the condition of the system. This choice of ratio of losses in the transformer is the main problem in choosing and the resultant economy on the system will depend largely on the skill of the engineer.

For a given transformer the effect of the change of losses can be seen by holding a constant Kva. output and varying the voltage for different ratios of copper and iron loss. For an increase of ratio of copper loss to iron loss the copper loss will increase much more rapidly than the iron loss will decrease. Hence the ultimate transformer temperature will increase and efficiency decrease. Transformers with a large ratio of losses are required only for peak loads of short duration, so that the temperature might not be objectionable. However, with present standard transformers the operation at normal load, so as to change the ratio of losses, will cause an increase in one loss much greater than the decrease in the other loss which is desired. Thus a transformer should be ordered to fit its position in the system and its ratio of losses considered beforehand.

On considering the total cost of the transformer the losses can be evaluated as a capital charge. This means that the losses during the life of the transformer are capitalized by considering interest and depreciation and the amount of cost obtained is the amount which represents the cost of the losses during the life of the transformer if paid at the time of the purchase with the transformer first cost. Thus the sum of the two will represent the total cost of the transformers.

METHODS OF EVALUATING LOSSES.

Let C = capacity charge per kilowatt of station and lines in dollars per year. C_1 = cost of energy per K. W. hr. in dollars. W = watts iron loss in transformer.

The iron loss is continuous so that it exists during 24 hrs. for each day of the year. Thus the iron loss in KW hrs. for one year = $24 \times 365 \times (W/1000)$.

The cost of generating this loss for one year is then = $(W/1000) \times C_1 \times 8760$.

To supply the loss the capacity required is $W/1000$ or the capital charge for capacity is $(W/1000) \times C$.

The total cost of iron loss = $(W/1000)\ (8760\ C_1 + C)$ in dollars per year.

To evaluate the loss due to magnetizing current we must consider that at light loads the loss due to magnetizing current is greater proportionally than that at full line capacity. The increase in line loss due to the magnetizing component of the exciting current is found to be the loss at full line load without the transformer multiplied by the quantity, [2 $\times$ wattless line component $\times$ magnetizing component + magnetizing component^2]. The quantities in the bracket are expressed as fractions of the line current.

If T is (transformer magnetizing current) ÷ line current, then, (magnetizing volt amperes) ÷ line volt amperes = T also.

If the line loss at load without transformer is expressed in volt-amperes as a fraction of, line volts × current = $K \times E\ I$, then the increase in loss is $K\ E\ I\ (2\ b\ T + T^2)$ volt-amperes, where T is the ratio as given above. Expressing volt amperes magnetizing current as $M = T \times E\ I$, the increased loss due to magnetizing current in line = $K\ M\ (2\ b + T)$ where b is the average wattless component. Thus as the average wattless component increases, the loss due to magnetizing current will increase for a given magnetizing current in volt amperes. The increase in current will be proportional to $K\ M\ (b + T/2)$ The line loss due to magnetizing current will be then equal $K\ M\ (b + T/2)$ watts.

The cost of line loss due to magnetizing current in the line is $K\ M/1000\ (b + T/2) \times C_1 \times 8760$ if b is the average wattless line component expressed as a fraction of line current.

The increased cost of the line will be $[M(b + T/2) \div 1000] \times$ Coct per Kva of line capacity. This evaluation considers that magnetizing current is made up of fundamental line frequency only and considers only that portion of the line between transformer and station.

COST OF COPPER LOSS.

C_1 = cost per kilowatt hour generated; C = cost per kilowatt station capacity; D = (Peak station capacity) ÷ connected transformer capacity; H = number of hours at full load during the day or equivalent hours at full load; W_c = watts copper loss at full load.

Cost of copper loss per year as in the case of iron loss is $W\ C/1000\ (365\ H\ C_1 + C\ D)$. The ratio D enters because the loads on the transformers do not all come at the same time and hence the station capacity required is less.

From the above the total cost of copper and iron losses can be figured together with the cost of magnetizing losses in the line. The cost of magnetizing current enters into station equipment also but for a station with a fairly good power factor the cost of magnetizing current will not be as much as for a station with a poor load factor. The cost of regulation can be figured if we consider the cost of lamp renewals and additional line loss for the same power under lower voltages. In any case, the value of iron and copper loss will be much greater and the determining features. The values of the losses should be determined in making the decision for the use of a given transformer or in obtaining a transformer for a given service..

FINAL CONSIDERATIONS IN ORDERING TRANSFORMERS.

As a final consideration in ordering transformers for a given service, the rating should be determined and based on a kilo-volt-ampere basis which is standard. This will avoid any misconception as to rating between purchaser and manufacturer. Thus a 100 Kw transformer for 80 per cent P. F. would be a 125 Kva transformer at 80 per cent P. F. or 125 Kw transformer at unity power factor. Since heating is dependent on Kva rating this should be the manner of specifying the heating and load.

Again in determining temperature rise, this should be specified as rise above the cooling medium. This cooling medium is sometimes water and sometimes oil and is air only when self-cooled transformers are used. If air is specified for a water cooled transformer, the temperature rise will be higher than what is really desired. If the air is 25° C and the ingoing water 15° C a temperature rise of 40 ° C above the air would be 50° above the water, and consequently, the transformer is running hotter than is actually desired when 40° C is specified above the air temperature. The temperature should be specified as rise above the cooling medium.

In determining the losses to be guaranteed, the total cost should be considered as mentioned above. To obtain any efficiency or regulation is a matter of amount of copper and iron and hence a matter of cost. If total cost is considered then a decision can be reached as to whether it is better to take a standard design or a special design.

In specifying efficiencies, the temperature at which it is to be determined is important. The temperature should be the temperature which the transformer reaches under the desired load after the desired length of time with the cooling medium at the temperature which it will be supplied to the transformer. To specify efficiency at any higher temperature is to get better efficiency at the operating temperature. This additional efficiency will add to the total cost of manufacture.

Again, if the transformer is desired to operate above its rated voltage at some later time, this must be considered along with efficiency and cost. With the high grades of nonaging steel, the tendency is to operate at high density thus decreasing the amount of iron or steel and copper. This means low first cost. However, an over-voltage condition will mean a great increase in magnetizing current and core loss. Thus if the voltage on the transformer is to be increased at some future time, say 10 per cent, it would be better to allow for this in ordering so that the transformer will be such that an increase of voltage will not require an excessive increase in core loss or magnetizing current. This would mean a higher efficiency transformer when first ordering allowing for the increase in core loss and magnetizing current at a later date.

In every case, when ordering a transformer the engineering and commercial conditions must be considered together so as to secure the best transformer for a given service.

Convention of Mississippi Electric Association at Meridian, Miss.

The sixth annual convention of the Mississippi Electric Association will be held at Meridian, Miss., April 27, 28 and 29. At the time this issue goes to press the nature of the program has not been made known, further than a statement to the effect that important phases of central station work will be presented by members and those with experience in the business of the state of Mississippi. A report of this convention will appear in these columns.

When things are not what they seem, remember this: What you get on your plate you got to eat—if you don't like it you can lump it—and if you can't lump it you must cut it up in smaller pieces—for there it is and there it will stay until you swallow it somehow.

An Important Steam Railroad Electrification Using Direct Current at 2,400 Volts

Details of First Steam Railroad Electrification Using 2,400 Volts D. C., Also First in This Country for Reasons of Economy.

In many ways the most interesting recent example of steam road electrification in this country is that of the Butte, Anaconda & Pacific Railway. Besides being the first 2,400 volt direct current road, it is also credited with being the first steam road operating both freight and passenger schedules by electrical equipment for reasons of economy. A number of steam railway electrifications have been made because of pre-emptory factors, such as terminal and tunnel operation, or for rapid suburban service; but this road cannot be classed as an "enforced electrification," since no such special limitations have been the determining factors.

The first electric locomotives were put in service May 28, 1913, hauling ore cars between the East Anaconda yards and the smelter. During the first seven months of service they made approximately 201,000 miles and hauled about 2,365,000 tons of ore. The change from steam to electric haulage was made without any change in the personnel of the train crews and without any delays or alterations in the schedule.

The electrified lines of this system extend from the Butte Hill yard to the smelter, a distance of 32 miles. There are numerous sidings, yards and smelter tracks that have been equipped with overhead trolley, making a total of about 95 miles on a single track basis. It is essentially an ore hauling road, the freight traffic from this source originating at the copper mines located near the top of Butte Hill. From the mines the ore trains are lowered down the mountain a distance of 4½ miles to the Rocker Yards, located a few miles west of the city of Butte. At this point new main line trains are made up for transportation to the smelters at Anaconda. The main line division extends through a rough, mountainous country a distance of about 20 miles, with grades as high as 0.3 per cent.

Between the cities of Butte and Anaconda, which are located at the ends of the electrified portion of the system, there is considerable local traffic, both passenger and freight. The city of Butte and vicinity has a population of about 65,000 and Anaconda about 10,000. At Butte, the Butte, Anaconda & Pacific connects with the Great Northern Railway, the Northern Pacific and the Chicago, Milwaukee & St. Paul Railroad, and at Silver Bow, about six miles from the city, connection is made with the Oregon Short Line. For a distance of 16 miles the Butte, Anaconda & Pacific Railway is paralleled by the transcontinental lines of the Northern Pacific and the Chicago, Milwaukee & St. Paul. The last named company has already contracted for power for the operation of electric trains from Harlowton, Mont., to Avery, Idaho, a distance of 440 miles.

Eight passenger trains per day are operated between Butte and Anaconda, four in each direction. The main line trains were first hauled by electric locomotives on October 1, 1913, and promptly demonstrated their ability to

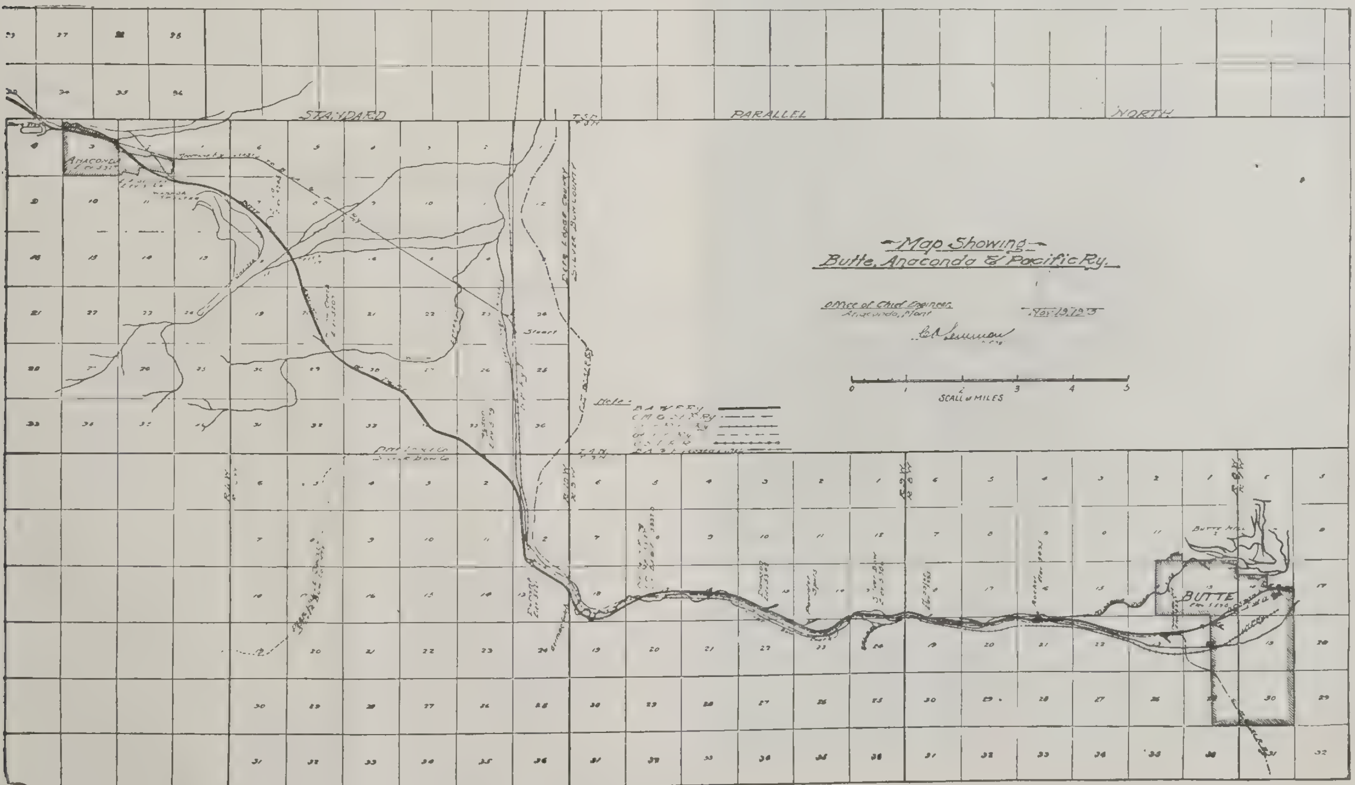


Fig. 1. Map of the Electrified Section of Butte, Ana conda & Pacific Railway.

make better time than was possible with steam engines. Single locomotives are used, hauling trains of from three to five pasenger and baggage cars.

POWER SUPPLY.

Energy for the operation of electric trains is purchased from the Great Falls Power Company. The generating plant is located at Great Falls, Mont., on the Missouri River, and has for some time been supplying electric power for the operation of the mines and smelters at Butte and Anaconda. Six hydroelectric units are installed, having a nominal rated capacity of 21,000 Kw. The machines are of the horizontal type, generating 6,600 volts, 3 phase, at a frequency of 60 cycles. The power is stepped up to 102,000 volts for transmission to the transformer substation at Butte, a distance of 130 miles, over two separate parallel lines constructed on the same right-of-way. An extension of the system transmits power at 60,000 volts to a second transformer station at Anaconda, 26 miles farther on.

The Butte station forms the center of the extensive power system operated by the Montana Power Company. Besides the Great Falls 102,000 volt transmission lines, there are several 60,000 volt transmissions terminating at this point, which form a part of the Montana Power Company's system. These lines bring in power from the Hauser Lake, Canyon Ferry, Madison and Big Hole plants. At the Butte substation this power is stepped down to 2,400 volts, 3 phase, and all of these lines are tied in on the 2,400 volt A. C. bus.

It is an interesting fact that the railway load was taken on without any increase in the high tension transmission facilities. It is estimated that the additional load from this source is approximately 20 per cent of the railway, industrial and lighting load furnished by the street railways, mines and smelters at Butte and Anaconda.

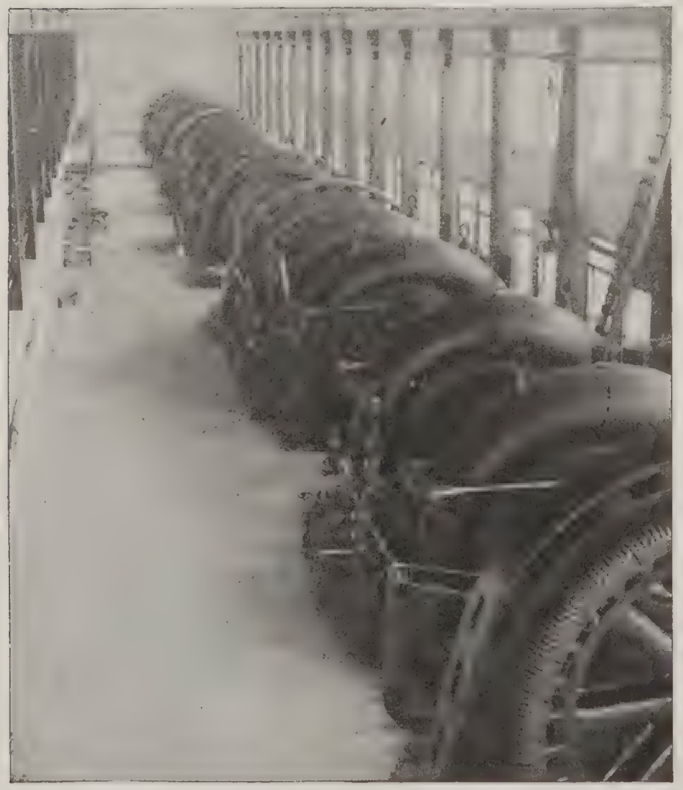


FIG. 2. GENERATOR ROOM IN RAINBOW STATION OF GREAT FALLS POWER COMPANY.

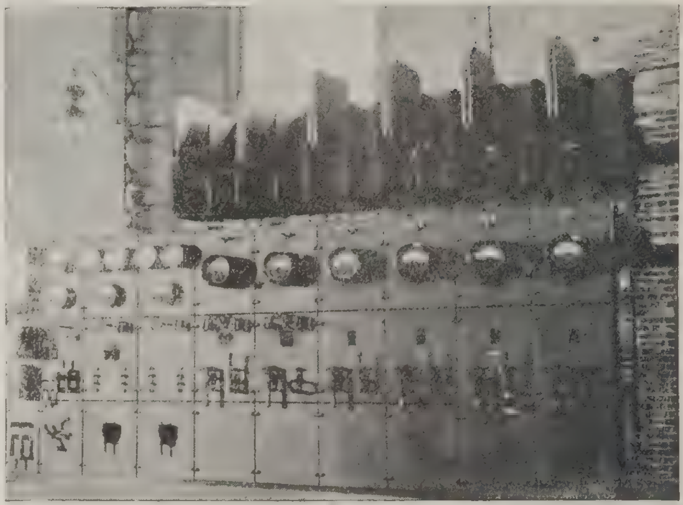


FIG. 3. SWITCHBOARD IN BUTTE SUBSTATION.

The two existing substations at Butte and Anaconda were used to house the 2,400 volt motor-generator sets required for operating the electric trains, so that no additional buildings were constructed for this purpose. Power is furnished by two 1,000 Kw., 3-unit motor-generator sets in each substation, taking power from the 2,400 volt A. C. buses. These units operate continuously 24 hours per day, seven days of the week, to supply the necessary current for train operation. Each set consists of a 3 phase, 60 cycle, 1,450 Kva., 720 r.p.m., synchronous motor, direct connected to two 500 Kw., 1,200 volt generators, insulated to operate in series for 2,400 volts. The generators are compound wound and have both commutating poles and compensating pole face windings. These fields are connected on the grounded side of the armature, and the main fields are separately excited from 125 volt exciters.

The 1,200 volt generators are provided with heat-proof insulation, and, owing to their unusually good commutating characteristics, will carry three times normal load for periods of five minutes, as well as the usual 50 per cent overload for two hours. An automatic voltage regulator is used to maintain an approximately constant voltage at the terminals of the motor by power factor regulation. The motors are protected against overload by inverse time limit relays, which are set to open at four times normal load. These relays have been adjusted to open under sustained overload in about two seconds, and upon short circuit their action is practically instantaneous.

Excitation for the two generating units in each substation is obtained from two induction motor-driven sets, rated 50 Kw. each at 125 volts. One set is used for supplying current to the synchronous motor fields and is controlled by the automatic voltage regulator. The second unit supplies current to the separately excited fields of the direct current generators.

The 2,400 volt switchboards for controlling these sets are the first direct current boards to be constructed for this high voltage. In general, they are similar to the standard 600 volt types, with increased insulation and special provision for interrupting the 2,400 volt current. The circuit breakers and switches are also arranged for remote control, and all apparatus on the panels is provided with ample insulation to insure safety to operators.

The 2,400 volt circuit breakers and switches are installed on separate panels above and back of the main panels, and are operated by connecting rods from handles mounted on the front of the main switchboard. These handles are similar in appearance; and, to avoid confusion, the circuit breaker handles are inverted. The breakers are equipped with special magnetic blowouts and arc chutes, and provision is also made for automatically inserting a high resistance in the generator field at the same instant the main circuit breakers open, thus reducing the generator voltage.

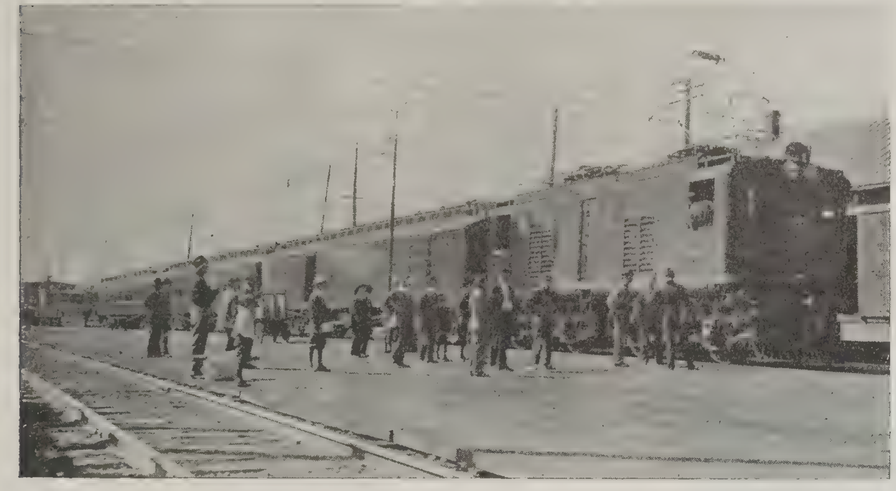


Fig. 4. Single Unit Electric Locomotive and Passenger Train at Butte Station.

The alternating current switchboard contains two panels for controlling the synchronous motors by means of remote control, solenoid operated oil switches; two panels for the motor fields, and a panel for the automatic voltage regulator. These panels also contain other necessary instruments, including frequency and synchronism indicators, ammeters, wattmeters and relays.

OVERHEAD CONSTRUCTION.

The overhead construction for this system was especially designed to give the flexibility necessary for satisfactory operation of the pantograph trolleys used on the locomotives. The 4/0 grooved copper trolley used over all tracks is supported by an 11 point catenary suspension from a stranded steel messenger cable. Both side bracket and cross span construction are used as required by the local conditions. There is a large amount of special work on account of the many yards and sidings, and in one case twelve tracks are spanned. The cross span construction used at this point is supported by a third pole between the eighth and ninth tracks. The hanger used on the straight line construction is a rolled steel strap looped over the messenger wire. This loop is closed at the car, and the wire is clamped in place by a single bolt. Special pull-offs are used to increase the flexibility of the suspension.

The section breakers were designed for the 2,400 volt service, and at six points insulated crossings are necessary at the intersection of the 2,400 volt trolley with the 600 volt trolley of the city system. On the main line a very simple section insulator is used. This consists of paralleling the two trolley wires from the ends of each section at a suitable distance for insulation, so that the pantograph bridges the two circuits for a short distance, thus avoiding interruption of the power supply to the locomotive. The construction in the yards and sidings is simplified by paralleling the trolley from the side tracks for a short distance along the main line. This avoids the use of switch plates or similar devices. At some of these junction points the pantograph engages as many as six trolley wires.

The overhead lines are protected from lightning by 2,400 volt D. C. type ME arresters installed on poles at intervals of one-third of a mile the entire length of the system.

FEEDERS.

The feeder layout with section insulators, switches, etc., is shown in the diagram. The 4/0 trolley is reinforced between the substations with two 500,000 c.m. bare copper cables, tapped to the trolley at intervals of 1,000 feet. A 4/0 negative return wire is also installed between Rocker and East Anaconda. This wire is carried on the trolley poles, and is connected to the cross bonds at intervals of 1,000 feet. The rails are connected by 4/0 bonds at every joint. The substations are normally connected together by these feeders, allowing an interchange of current. In emergency either station can supply current to the entire system.

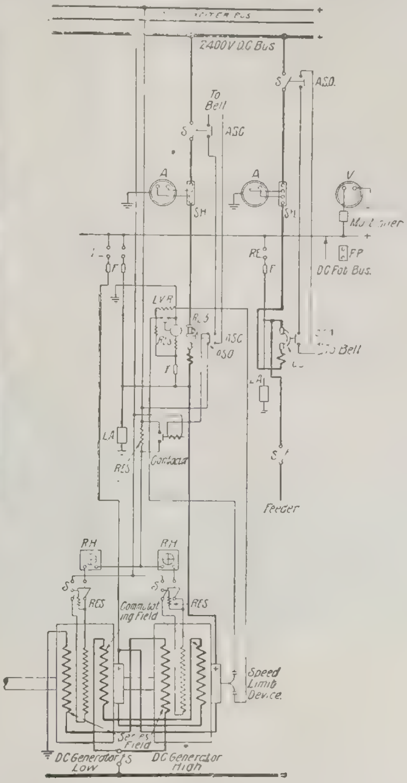


Fig. 5. Wiring Diagram of Substations.

ELECTRIC LOCOMOTIVES.

The locomotive equipment consists of seventeen 80-ton units, fifteen for the freight and two for passenger service. The freight locomotives are geared for slow speed and are operated in pairs for the main line service. The maximum free running speed is 35 m.p.h. The two passenger locomotives are of the same construction as the freight units, but are geared for a maximum free-running speed of 55 m.p.h. A speed of 45 m.p.h. is made with three passenger coaches on straight, level track. The continuous tractive effort of a single 80-ton freight locomotive is 25,000 pounds at 15 miles per hour. The maximum tractive effort for a period of five minutes is 48,000 pounds, based on a tractive coefficient of 30 per cent.

These locomotives are of the articulated double truck type, with all the weight on drivers. The cab contains an engineer's compartment at each end and a central compartment for control apparatus. This cab is of the box type, extending the entire length of the locomotive, and is provided with both end and side doors. The entire weight of the locomotive is carried on semi-elliptic springs suitably equalized.

The central channels forming a part of the underframe are enclosed and are utilized as a distributing air duct for the forced ventilation of the motors. The air is conducted through the center pins, which are hollow, into the truck transoms and thence to the motors. The engineer's compartment at either end of the car contains the operator's seat, controller, air-brake valves, bell and whistle ropes, ammeter, air gages, sanders and other control apparatus within immediate reach of the engineer.

FIG. 6. TWO UNIT ELECTRIC LOCOMOTIVE HAULING FREIGHT TRAIN.

The contractors, reverser and rheostats, which are located in the central portion of the cab, are mounted in two banks running lengthwise of the compartment, and are conveniently arranged for cleaning, inspection and repair. All apparatus and circuits carrying 2,400 volts are thoroughly protected from accidental contact.

The motors are of the GE—229—A commutating pole type, wound for 1,200 volts and insulated for 2,400 volts. This motor was designed for locomotive service and is provided with forced ventilation.

The control equipment is Sprague-General Electric Type M, multiple unit, operating the four motors in series and in series-parallel. Two 1,200 volt motors are permanently connected in series. The controller provides ten steps in series and nine in series-parallel. The transition between series and series-parallel is effected without opening the motor circuit, and there is no appreciable reduction in tractive effort during the change. The transfer of circuits at this point is made by a special change-over switch, which is operated electro-pneumatically.

Current is collected by overhead roller pantographs, pneumatically operated and controlled from either engineer's compartment by an air valve. A 2,400 volt insulated bus line runs along the center of the cab roof. These bus lines are connected together by couplers between the two freight units, so that current may be obtained from either one or two collectors. The air brakes are the combined straight and automatic type, and the compressor is of the CP-26, 600 volt type, having a piston displacement of 100 cubic feet of air per minute when pumping against a tank pressure of 135 pounds. Radiating pipes are provided on the roof of the cab for reducing the temperature of the compressed air before it reaches the high pressure cylinder.

For operating the control equipment and air compressor, and for lighting the locomotive and cars, 600 volt current is supplied from the 2,400/600 volt dynamotor installed on each locomotive. This machine is similar in construction to the 1,200/600 volt dynamotor, having two distinct sets of armature coils wound on the same core and brought out to a commutator at each end. One of these windings is designed for 1,800 volts and the other for 600 volts, the two commutators being connected in series across the 2,400 volt circuit. The load current is taken from the 600 volt commutator.

LIGHTING THE PASSENGER COACHES.

Standard 600 volt lighting fixtures will be used on the cars, and each passenger and baggage coach will be wired for five groups of five lamps in series. The lights in each car will be controlled by a suitable master switch and fuse, with snap switches in the individual circuits. Thirty-six watt railway type tungsten lamps are used, giving about 26 c.p. at 110 volts per lamp. Lighting current will be taken from a 600 volt train line bus, which is connected to the dynamotor on the locomotives.

All of the passenger and baggage cars now used between Butte and Anaconda will be heated as well as lighted by electricity as soon as the equipment can be installed. The cars will be heated from a single heating unit installed underneath the car floor, and supplied from a 2,400 volt bus connected directly to the 2,400 volt bus on the locomotive. This unit will have a maximum capacity of 25 Kw., and will be used to heat the air which is distributed to different parts of the car by means of a small motor-driven blower. Cool air will be drawn into the insulated case enclosing the heating units from some point on the roof of the car. After passing over the heating coils, the air will be carried through ducts under the floor of the car to radiators placed between alternate seats. The blower has a capacity of from 500 to 1,000 cubic feet of air per minute, and the motor is connected in series with the heating units.

In order to increase the range of the heating equipment to meet the requirements of varying temperatures, provision is made for connecting the coils to give a total consumption of 10, 15, 17.5 or 25 Kw. The temperature of the car is regulated at all times by a thermostat.

All apparatus for the electrification of this road was furnished by the General Electric Company, of Schenectady, N. Y.

Educational Work in the Use of Standard Electric Wiring Materials.

BY J. E. LATTA, SPECIAL AGENT, UNDERWRITERS' LABORATORIES.

THE time when electric service was contracted for as an experiment, while not many years ago, is far enough back in the history of electrical development to be considered the very early stage of the application of electricity. Today so many uses of electrical energy exist on every hand that those who have very little knowledge of the technical considerations in connection with its generation, distribution or application seldom question the satisfactory operation of the electrical device when they have occasion to make use of same. This confidence in electricity as a useful servant has not been brought about without much educational work on the part of manufacturers and central station companies; and while a large part of the work has been done, there still remains a field for further cultivation—namely, better and more substantial preparation and construction when contracting for electric service. In regard to the use of better standards of electrical wiring, Mr. J. E. Latta, representing the Underwriters' Laboratories of Chicago, had the following to say at a recent convention of the Electrical Supply Jobbers' Association at Washington, D. C.:

Since the property owner today realizes that the wiring in his building will be needed as long as will the walls themselves, why should the installation of flimsy, unstable wiring continue to be so common? Why is it that it is still easy to find a market for sub-standard wiring materials? The question is one frequently discussed and sometimes at great length. It has been asserted that the cheap contractor is largely to blame. That he is wholly blameless none of us would undertake to deny. Some of our friends would have us believe that the zeal of the central station manager for connecting up new business likewise contributes to the disorder. While such a contention is not wholly without foundation, my own feeling is that this matter is made more of than the facts justify. For example, I know personally of many towns where the lighting company, without any local ordinance to demand it, refuses to connect to any building in which the wiring has not been inspected and found to comply with the specifications of the National Electrical Code. After all, is it not true that the real cause of the trouble is the ignorance of the public as to what constitutes standard electrical work, and that the real remedy is to be sought in the education of the public in this matter?

In purchasing other things than electrical supplies, the average citizen seldom makes low price the principal consideration. Quality, not price, is the first thing taken into account, as a rule. Is it at all reasonable to insist that this would not be the usual procedure in the purchase of electrical materials if the purchaser really knew the meaning of quality in goods of this class?

It must be admitted, however, that it is much easier to convince ourselves of the necessity of a more general education of the public in the use of standard wiring materials than it is to work out definite plans for accomplishing such education. It is a question, in fact, as to whether or not the desired degree of education is possible at all. The time will probably never come when even the most intelligent layman will be able to distinguish between the better and the less desirable grades of electrical goods in a satisfactory way. He will probably always have to depend largely upon some other authority than his own judgment, so that the greater his confidence in a properly constituted authority the better. One who has made any considerable study of existing conditions cannot but feel, therefore, that the thing most needed is a more wholesome and more general appreciation of the National Electrical Code.

Although, like all other things, the Code falls short of perfection, it is probably not too much to say that lack of confidence in it can arise from no other cause than ignorance as to how its rules are made and revised. The committee in charge of revising the Code is made up of representatives of practically every branch of the electrical industry. Suggestions as to changes in the rules may be submitted by anybody who cares to, and such suggested changes are passed upon by the committee and its recommendations reported to an open meeting. It is here that the final adoption or rejection of any proposed amendment occurs, and any man who so desires may attend this meeting, join in the discussion and vote. It seems, therefore, that there could be no more satisfactory way of making a set of rules. The Code is, on this account, the most democratic of documents.

The foregoing is a story that the public ought to know better. Electrical advertising and electrical salesmen can help to make the nature of the Code more popularly known and thus make the road rougher for the pirate dealer in electrical supplies—the dealer whose principal claim to consideration is the fact that he can undersell his competitors—the fellow who is always ready to push the sale of sub-standard materials. When I have called upon municipal officials with a view to convincing them that it is a mistake for any town to permit the use of Old Code wire, I have had no trouble in showing them the difference between the old wire and the new, but the bare statement that the Code specifies 1911 wire for concealed work has by no means always been convincing. There has been a demand for information as to what this source of authority—the so-called "Code"—is.

There is a town where sub-standard wiring and the use of nondescript, hazardous fittings was for years the rule. Finally there went into this place an electrical contractor who put on a campaign of advertising. In the daily newspapers he told the public, in bold-faced type, what standard wiring means. He is now getting a large share of the wiring business in that town, and the first thing that his principal competitor does now when a prospective customer enters his place of business is to assure him that he sells only approved materials. That contractor is an educator; every salesman of electrical materials ought to be one. Ability to take orders for cheap goods is not salesmanship. When the lamp manufacturers wanted to educate the public to the use of tungsten lamps three or four years ago, they proceeded by training their salesmen to the task.

Another thing that is important is that the public know more about the work of the Underwriters' Laboratories along electrical lines, and that for such information they must in a measure depend upon the men who are selling electrical supplies. The writer has met salesmen on the road who were very properly making the fact that their goods were on the approved list a strong argument for consideration with any prospective customer who had very incomplete notions as to what approval really means. For example, I have found salesmen who thought that when any given product of any particular manufacturer had been admitted to the laboratories' "label service," the manufacturer was entitled to apply labels to any unit in this class of products which he might offer for sale. As a matter of fact, however, the "Label Service" amounts to continuous supervision of the manufacturers' goods at the factory, and, as far as is practicable, this supervision is reinforced by following up the behavior of the labeled appliance or material in the field. For example, in the case of rubber-covered wire the laboratories' inspector at the factory tests enough of the factory output to convince him that the coils to which labels are to be applied are standard, and then there is what we consider a very complete field follow-up system. From time to time our representatives in the various parts of the country purchase coils of wire from the stocks of local dealers and send them to the laboratories for examination and test. Moreover, there has lately been adopted the practice of sending out to every electrical inspector who will use them cardboard tags for mailing samples of wire of doubtful quality to the laboratories. The inspector who finds wire that seems to him to be sub-standard material uses this tag to forward a 2-foot sample of it to the laboratories, and gets a prompt report of the result of the laboratories' test on the samples submitted without any charge whatsoever. Inspectors have manifested a disposition to co-operate heartily in this sort of follow-up scheme, and the tests on the samples of wire submitted for examination have led us to believe that the use of sub-standard wire is not nearly so extensive as one would expect it to be, when there is taken into consideration the ignorance of the public in some quarters as to quality of wire and the always seductive prospect of saving a dollar on a wiring installation.

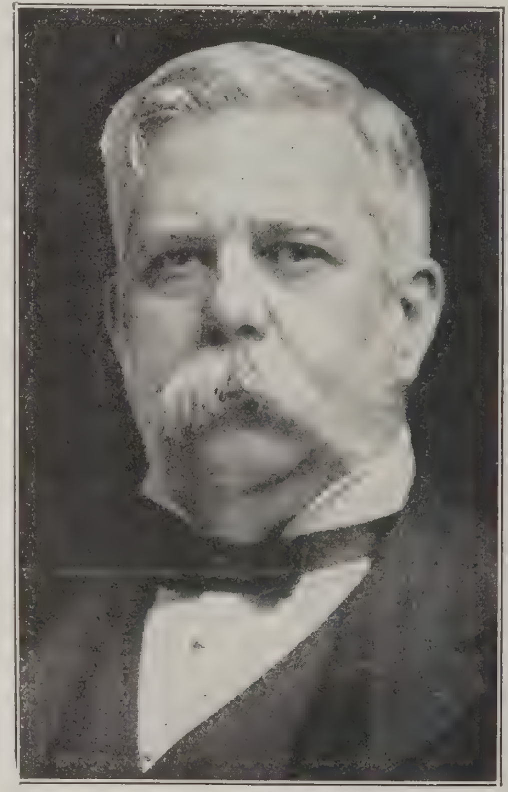
The Underwriters' Laboratories is desirous of having the public know intimately of its work. We are in the field for service, and not for profit. Our natural field, so far as the electrical industry is concerned, is the examination of materials to see that they conform to the requirements of the Code, but no opportunity is passed to do what we can toward educating inspection departments and the public to require standard materials.

Life of George Westinghouse.

George Westinghouse, the famous inventor and engineer, died of heart disease at his New York City residence on Thursday, March 12. His health had been failing for some time, and consequently his death, though a great shock to his friends and acquaintances all over the country, was, nevertheless, in a measure anticipated, for during the last few years he had begun to transfer his responsibilities to the shoulders of his trusted lieutenants, the fortunate selection of which has always been one of the leading characteristics of his varied career.

Mr. Westinghouse was born at Central Bridge, Scholarie County, N. Y., on the 6th of October, 1846. His parents were George and Emeline Vedder Westinghouse. The father's ancestors came from Germany and settled in Massachusetts and Vermont before the Revolution, and his mother's ancestors were Dutch-English. Mr. Westinghouse's father was also an inventor, who, in 1856, removed his family to Schenectady, N. Y., where he established the Schenectady Agricultural Works. The boy attended the public and high schools of the town, spending much of his leisure time in his father's machine shop. Before he was fifteen he invented and made a rotary engine, and passed at an early age the examination for the position of assistant engineer in the United States Navy. In June, 1863, though barely seventeen, he enlisted in the Twelfth New York National Guard, and was discharged at the expiration of November of the same year to join the Sixteenth New York Cavalry, being chosen corporal. He was honorably discharged in November of the following year, and a month later accepted an appointment as third assistant engineer, United States Navy, reporting for duty to the Muscota, from which he was transferred to the Stars and Stripes and detached and ordered to the Potomac flotilla June 28, 1865. At the close of the war, resisting solicitations to remain in the navy, and wishing to continue his college studies, Mr. Westinghouse tendered his resignation and was honorably discharged August 1, 1865. On his return he entered Union College, where he remained until the close of his sophomore year, and, obedient to his impulse toward experiment, abandoned his classical studies and entered upon active life to find a wider scope for his inventive genius.

In 1865 Mr. Westinghouse invented his first railroad device for replacing railroad cars upon the track, which, being of cast steel, was manufactured by the Bessemer Steel Works at Troy, N. Y. Going to Troy one day, a delay, caused by a collision between two freight trains, suggested to him the idea that a brake under the control of an engineer might have prevented the accident. His first thought was an automatic brake attached to the couplers, which was unsuccessful. This was followed by steam, which proved also to be unsatisfactory, because by the time it reached the brake from the engineer's cab it lost its power. At this point Fate seems to have entered his life. In the pages of a magazine—which he had subscribed to through the solicitation of a young girl—he saw an account of the use of compressed air in digging the Mont Cenis Tunnel, three thousand feet under ground. The inventor began to think over the matter, and, after much further study and investigation, the use of compressed air further impressed itself on him. Drawings of the air-pump, brake cylinder and valves were made, but considerable time elapsed before a practical trial of the brake was obtained. The first patent was issued April 13, 1869, and the Westinghouse Air Brake Company was formed on the 20th of July following. During the next few years Mr. Westinghouse invented the "automatic" feature of the brake, which overcame the imperfections in the first form and removed the danger from the parting of trains on steep grades. In 1886 he invented the "quick-action" brake, the improvement being made in what is known as the "triple-valve." By this valve it became practicable to apply all brakes on the train of fifty freight cars in two seconds. The automatic and quick-action brakes are regarded by experts as surpassing the original brake in ingenuity and inventive genius, being not



MR. GEORGE WESTINGHOUSE.

merely improvements, but distinct inventions of the highest class, unique and remarkable.

About 1880 Mr. Westinghouse became interested in the operation of railway signals and switches by compressed air, and soon afterward there was developed and patented the system now manufactured by the Union Switch & Signal Company. In 1886 the Westinghouse Electric Company was formed for the manufacture of lamps and electric lighting apparatus. The business rapidly developed, and in 1889 and 1890 this company absorbed the United States Electric Company and the Consolidated Electric Light Company. In 1891 all these properties were reorganized into the Westinghouse Electric & Manufacturing Company, which now operates an extensive works at East Pittsburgh, employing over 32,000 people.

In 1892 Mr. Westinghouse secured for the Electric Company the contract for the electrical equipment of the World's Fair at Chicago, and in 1893 the contract for the large generators at Niagara Falls, both of which marked epochs in the progress of the electrical industry. In 1895 the Electric Company outgrew the small quarters at Garrison Alley and moved to East Pittsburgh, and the same year works of the British Westinghouse Company were established at Manchester, England.

The question of the steam turbine and its applications was at about this time investigated by Mr. Westinghouse, and he secured the patent rights of Charles A. Parsons, of England, on the turbine in 1897-98. This development of a new prime mover soon led the inventor to consider the use of the turbine as a prime mover for ships, and the trouble with high speed caused him to develop one of the most ingenious features of modern mechanical engineering—the mechanical reduction gear for reducing the inherently high speed of a turbine to the slow speed of a ship propeller or direct current dynamo. He accomplished this work in collaboration with the late Admiral George W. Melville, U. S. N., and John H. MacAlpine. Within the last few years he also occupied himself with the development of an air spring for automobiles and motor trucks.

In connection with alternating current transmission, Mr. Westinghouse has rendered an invaluable service to the electrical development of the world, and in spite of opposition, ridicule and other efforts to crush his alternating current system, he remained steadfast in his belief that this class of high tension transmission would make distanct electrical distribution possible. This system his engineers developed, and incidentally in this connection secured Nicola Tesla, 1887, who invented the alternating current induction motor. The world, today lighted by distant waterfalls and central stations, now recognizes its debt to Mr. Westinghouse's foresight and perseverance. A struggle almost identical with that of the earlier fight for alternating current transmission is the recent development of alternating current traction by means of the single phase motor, which the Westinghouse Electric & Manufacturing Company has now wrought into an accomplished reality in the case of a number of traction lines, railroad terminals and tunnels.

On account of his many achievements in mechanics, electricity, steam and gas, his name is known the world over, and many honorable distinctions have been conferred upon him in recognition of the services he rendered the various branches of engineering. His *alma mater,* Union College, of Schenectady, conferred upon him the degree of doctor of philosophy. He was decorated with the order of the Legion of Honor, with the order of the Royal Crown of Italy, with the order of Leopold of Belgium. He was the second recipient of the John Fritz medal. He received the degree of Doctor of Engineering from the Koenigliche Technische Hochschule of Berlin, Germany. He was an honorary member of the American Society of Mechanical Engineers, of which body he was also president in 1910. He was one of the two honorary members of the American Society for the Advancement of Science. He was an honorary member of the National Electric Light Association of America. He was awarded the Scott premium and medal by the Franklin Institute of the State of Pennsylvania. He received the Edison gold medal for meritorious achievements in the alternating current system of electrical distribution. He received the Grashof gold medal from the Society of German Engineers in Germany, which acknowledged him the greatest American engineer.

Mr. Westinghouse was connected with a large number of industries at home and abroad, many of which bore his name. He was president and director of the Westinghouse Air Brake Company, Westinghouse Machine Company, Nernst Lamp Company, The Union Switch & Signal Company, Societe Anonyme Westinghouse (Paris), Cooper Hewitt Electric Company, Pittsburgh Meter Company, Societe Italiene Westinghouse (Italy), The East Pittsburgh Improvement Company, The Westinghouse Brake Company, Ltd., London; Westinghouse Cooper Hewitt Company, London; Westinghouse Friction Draft Gear Company, Westinghouse Metal Filament Lamp Company, Ltd., London. He was also chairman of the Board of Directors of the Westinghouse Electric Company, Ltd., London, and director in the Westinghouse Electric & Manufacturing Company, The Traction & Power Securities Company, Westinghouse Metallfaden Gluhlampenfabrik, Vienna. Mr. Westinghouse was married August 8, 1867, at Brooklyn, N. Y., to Marguerite Franklin Walker. They had one son, George, who is a graduate of Yale and was recently married to Evelyn Violet Brocklebank. His wife and son survive him.

Reinforced concrete poles are giving a good account of themselves. During the recent blizzard when gales of 70 to 80 miles per hour swept over the Hackensack meadows in New Jersey, near New York City, leveling nearly everything before it, they withstood the blasts nobly. Even though the gale in some cases stripped them of their wooden cross arms the poles stood uninjured.

So many birds chose the electric signs in New York as resting places during the recent cold snap, that the appearance suffered greatly.

Strangely enough, one of the most annoying sources of interruption on transmission lines comes from animals. A few years ago, in New York, a pair of large birds alighted upon two separate wires of a live circuit. All went well until the amorous birds began to "bill and coo," and then it happened. In a recent paper some further incidents are mentioned. A heron and a crane got into trouble and in the excitement involved a transmission line by flying into it. A pair of mice played havoc with an underground cable, and suffered death by cremation; an owl nestled under a high tension insulator to his sorrow, and a squirrel came to the same unhappy end.

New Business Methods and Results

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

Commercial Accounting Forms and Methods.

In what follows we present our views on some commercial features relating to the work of the accounting department, having reference particularly to those accounts and records which concern relations with the customer.

There seems to be a growing tendency for the commercial manager to "butt in" as it were, in the work of other departments and while it is not to be expected or desired that he should exercise the functions or usurp the authority of the auditor or the plant superintendent, yet he is and should be vitally interested in anything pertaining to the company's commercial growth, and is frequently in a position to make suggestions of value. This is especially true on account of the fact that it is very difficult to get employes in the operating, and especially in the accounting department, to look at things from the customer's standpoint. Men who are commercially trained, however, and who know from experience the effort required to get business, will appreciate its value and the methods best adapted to keeping it.

All accounts with customers should be kept simply, neatly and accurately, and in such a way as to show instantly the charges, payments, and balance without prolonged calculation. Disorder, intricacy, and mystery, inevitably suggest carelessness, juggling, or dishonesty. The account should be so kept that the ledger page or card can be freely exhibited to the customer so that he can see for himself just how the bill is figured up. It is universal experience that we mistrust the mysterious, but have confidence in what we understand. Many a customer feels much better even after being shown how to read his or her meter for there is always a satisfaction in knowing about the inside workings of anything. A telephone subscriber in Philadelphia had the reputation of being a chronic kicker. He was constantly finding fault with the service, the charges, and the operators. One day he was invited to take a trip through the Walnut St. exchange, and was courteously taken through the entire building and every feature fully explained. From that day forth, his attitude was completely changed, and he is a good friend of the company, simply because he has "seen the wheels go round."

As regards the forms and handling of bills, work orders, stock records, line trouble records, and meter reading books, etc., we find that they all have more or less of commercial significance. In general forms sent to customers should be simplified to the last degree consistent with their purpose. This advice is applicable especially to the monthly bill, both because it is by far the most frequent visitor to the homes of customers, and because it represents a prominent point of contact between the corporation and the public, and as such, is always a matter of acute interest.

The question of form of bills depends largely upon the rate schedule, which question we will discuss here. It goes without saying that the bill should be easily understood, that is, it should show how the result is secured. Nothing is perhaps more annoying to a customer than to get a bill that he does not understand, and cannot verify. A bill based on a meter reading should give the readings for the beginning and end of the term, showing definitely when the readings were taken, the difference, the rate on which the service is billed, and the net amount. In case of block or step rates, the bill should be so worded that the customer can easily see how the amount is computed. If necessary to a proper understanding of the bill, the rate schedule may be printed on the back, but in general it should be as simple and free from unnecessary matter as possible. The practice of printing advertisements on bills, or enclosing them therewith is to be condemned.

As regards accounts for wiring, appliances, rentals, etc., these should be kept entirely separate and apart from those for electric current. Bills should also be rendered separately. It is the practice among some companies to add the appliance charge to the charge for current and if not paid promptly, threaten disconnection unless the whole amount is paid. Such a course is most likely to create ill feeling, and it is very doubtful whether it can be legally defended. The current and other additional service are contracted for separately, and it is questionable whether one contract can be relied upon to enforce payment on the other. Wiring contracts usually are, or should be in the form of a lease, so that action can be taken readily in case of non-payment. The same would apply in case of appliances sold on the installment plan. Wherever possible, it is much better in case of non-payment to gain possession of the appliance in question than to resort to legal procedure.

As to the form of bill for appliances, it seems that the accounting could be greatly simplified, by making out such bills in duplicate, the copy to be perforated for a binder, in which the copies would be filed alphabetically and these copies of the bills constitute the ledger. Payments should simply be credited on the duplicate bill, and when the account is fully paid, the copies should be transferred to a "paid" file.

With work orders and stock records, we have but little direct interest, except in as far as they may assist or hinder proper service to the customer. The keeping of proper accounts in any department will naturally facilitate service and hence indirectly be of commercial interest. In case improper service can be traced to cumbersome and inaccurate records in the line or stock departments, it would be in order for the commercial manager to suggest something better.

The proper keeping of line trouble records, and in fact, trouble records of any kind is of undoubted commercial significance, because prompt attention given to such trouble makes for good will. Accurate records aid directly in clearing trouble, and adjusting disputes arising over many cases, but more particularly in furnishing information which can be used to prevent recurrence of same. To this end, such records should indicate accurately the location, nature of trouble, and remedy to be applied.

Complete maps of systems, showing routes and sizes of all lines, positions of poles, transformers, underground lines, with manholes, etc., are indispensable. Frequent voltmeter tests at different points, at time of peak load, will serve to keep the manager informed as to the treatment of claims alleging poor light. Outages from whatever cause should be carefully recorded indicating just what feeder or feeders were affected, the cause and the duration. These records, as far as possible should be kept in such shape as to be quickly accessible in cases of dispute, not to afford an arbitrary ground for decision, but as an aid in arriving at a reasonable settlement.

Forms for meter reading are of commercial interest, since they form the basis on which practically all accounts are rendered. Meter reading forms have become pretty well standardized, and the form which is coming into general use is a loose leaf with five vertical and 12 horizontal rows of small meter dials printed thereon, thus providing for recording the consumption of one customer for one year. The meter reader marks carefully the position of each hand on each dial. This is preferable to writing down the figures, because it offers less chance of mistake.

These are the principal accounting records which in any way affect commercial growth, and the same rules may be held to apply to all, namely, simplicity, accuracy, and completeness. If these are observed, it will undoubtedly aid in improving the quality of the services rendered, and hence be a factor in extending the business. A. G. Rakestraw.

Current Topics and Events in Central Station Fields.

Central station statistics compiled by the Bureau of Census show that in 1912 there were 5,221 central stations in the United States, of which 3,659 were operated by private capital, and 1,562 by municipalities. The income totalled over 300 millions of dollars and nearly 80,000 persons were employed. The total power developed amounted to 7,500,000 Hp., of which nearly five million Hp. was produced by steam power, two and one-half million by water power, and about one hundred thousand by oil and gas engines. A total of over 11.5 billion Kw. hrs. was generated, supplying a load of 500,000 arc lamps, 76.5 million incandescent lamps, in 16 c. p. equivalents, and 4 million horse power in motors.

ISOLATED PLANT COMPETITION.

A bill recently introduced in the Kentucky legislature has for its object the protection of the central station from competition from private plants supplying adjacent buildings, or "block plants" as they are called. While at first thought this might not seem a matter for legislative interference, yet when we consider that the private plant has practically no distribution expense, while the central station by the terms of its franchise must extend its lines throughout the city on demand, we see that the private plant gets the cream of the business while the central station by law, must be content with the average. This of course necessitates higher rates to customers in non-competitive territory, and hence amounts to discrimination.

POWER APPLICATIONS.

Chickasha, Okla., is using central station power for the municipal water system and finds the operation to be much less expensive than doing the pumping for themselves.

Motor driven irrigation prospects are under active development in California. In a certain section use is made of 3-phase, 220-volt motors pumping from wells 30 to 50 feet deep. One pump is sufficient for each 5 or 10 acre tract. Another development company has gone into the irrigation business on a large scale, having purchased several thousand acres and selling tracts to farmers on attractive terms. The company will even finance the erection of the necessary buildings, fence the land, and start the purchaser up in the stock business.

The Walker Ice Co. of Worcester, Mass., uses a 35 Hp. motor for sawing natural ice. The ice is cut on ponds in 12 by 18 foot cakes and floated into a narrow channel, pushed first under one set of saws, and then under another, being thus divided into 63 cakes of ice in about half a minute. From here they are hauled up by a hoisting chain into the ice-house. A curious fact is that when the saws are cutting through the cake of ice the power required is only about half that taken when they are revolving in the water.

ELECTRIC VEHICLES.

Recent tests in St. Louis give the average cost of a pleasure vehicle kept in a public garage, at about $15 per month, exclusive of charging current. In the opinion of Mr. Michael of the Union Electric, this can be reduced to about $10 when the car is kept at home. As a comparison, we might say that the Electric Vehicle Association of America gives an average cost of upkeep and current combined at $23.50.

The New York Edison maintains 24 emergency charging stations where truck drivers may obtain a "boost." The firm's name on the truck is sufficient credit.

Whatever may be the popular opinion regarding the ability of electric vehicles to climb hills, it should surely set discussion at rest to learn that a regular electric bus service is now maintained over the Alps, between Switzerland and Italy. In each bus 22 passengers are carried.

The Adams Express Company has added 20 more electric trucks to its mail equipment in New York City. This makes a total of 150 vehicles now in use in this work.

Electric baggage trucks are now being largely used for conveying baggage and mail from and to trains in passenger stations. The operator stands on a very low platform on the front of the truck, with a short lever in each hand. From this position he has perfect control of the truck even among crowds of passengers who frequently fill the platforms. Obviously electricity is the only motive power suitable for this work.

ILLUMINATION AND ADVERTISING.

At Indianapolis, Ind., a plaza surrounding the Sailors and Soldiers monument is now lighted with 48 750-watt nitrogen filled tungsten lamps. Each lamp gives 1100 c. p. and the power required is 36 Kw. When we consider that a very few years ago, this illumination would have required 192 arc lamps taking something like 96 Kw. or about 3,000 16-c. p. incandescent lamps with a combined consumption of around 175 Kw., we can get an idea of the really marvelous advance which has taken place in electric lighting.

The Hess-Bright Co., whose factory is located along the Pennsylvania Railroad, near Philadelphia, has adopted a rather novel method of advertising by concentrating the rays of a powerful search light upon its buildings. The light is placed on a steel tower 250 feet away and is operated for about 5 hours every night. The power required is 5.5 Kw. and the effect is brilliant, to say the least, the entire building being literally bathed in light.

NEW BUSINESS NOTES.

The Commonwealth Edison Co., of Chicago, is conducting a campaign for industrial lighting. Some 2,000 units have been installed varying from 100 to 250 watts each. These units are rented for 25 cents per month and at the end of two years become the property of the customer. They are also maintained for 25 cents per month additional, lamps being replaced, and the units cleaned every 10 days. The current is charged for separately.

Cambridge, Ohio, has an electric corner. Not that the supply of "juice" is "cornered," but that the local company has established new headquarters on what was originally a rather poorly lighted street corner, and by the lavish use of light inside and outside, has made it so bright as to have earned the above designation.

Since December 7, 1913, Mr. Robert Montgomery, the energetic new business manager of the Louisville (Ky.) Gas and Electric Company, has secured house wiring contracts to the extent of $10,845.89. He says the campaign is not yet under way and that he plans to secure about 4,000 new customers during this year. Note what he says elsewhere in this issue and keep an eye on his results and methods. This kind of business is not new with him—he did the same thing at Fort Worth, Texas.

The commercial department was rearranged during the summer of last year under the direction of E. L. Callahan, new business manager of the H. M. Byllesby Co., and during the six months ending Feb. 1, 1914, the department has secured contracts for 6,479 horsepower of new electrical business from 2,159 new electrical customers. The new lighting business contracted for aggregated 3,034 horsepower and the additional power business 3,433 horsepower. Of the total 1,835 horsepower will replace isolated power plants. During the six months period future delivery contracts for natural gas for industrial purposes were secured calling for an estimated annual consumption of 221,640,000 cubic feet. All these industrial gas contracts were taken upon the ordinary rate of 35 cents per thousand cubic feet. Natural gas from the West Virginia fields was turned into the Louisville mains March 14, and it is expected that within a short time contracts for large additional amounts of gas for industrial uses will be closed.

Kansas City has a housewiring campaign on. Twelve months are allowed for payment but most of the accounts are settled within 3 or 4 months. In 2½ years over 3,600 houses have been wired.

The Lighting Co. at Springfield, Ill., has put in 80 electric signs during the past year These use altogether 9,600 5-watt tungsten lamps.

The East Liverpool (Ohio) Traction and Lighting Co. has been rapidly increasing its residence load. It has about 1,400 excess indicators on their lines, over half of which have been connected during the past year.

Union Electric of St. Louis has doubled its appliance sales over that of a year ago.

Safety First Campaign of Union Electric Light & Power Company.

A "safety first" campaign has been launched by the Union Electric Light and Power Company, the first step being the organization of a Safety Committee, the members of which will be known as the "Central Safety Committee." The following is the personnel of the committee: John Hunter, chairman; C. S. Ruffner, H. Spoehrer, H. W. Eales, J. L. Fay, E. S. Wills, F. C. Brooks and G. S. Hessenbruch, with an additional member to be appointed by Mr. Ruffner; Mr. Spoehrer to be Secretary of the committee. The work of the committee will be divided into four parts:

1. Analysis and discussion of accidents that have happened, with the object of preventing their repetition.
2. Analysis and discussion of circumstances and conditions under which accidents might happen, in order to keep down the number of preventable accidents.
3. Recommending the installation of safety devices, with a view of preventing accidents.
4. Passing upon matters of standard practice, with "Safety" object in mind.

Suggestion cards for the prevention of accidents are to be issued to all employes in order to give the rank and file an opportunity to point out unsafe practices and make recommendations of a "safety" nature. These cards when received with suggestions from employes are to be turned over to the central committee. Meetings of the central committee are to be held from time to time, to which employes in a supervisory capacity are to be invited. The idea of these meetings will be to open the minds of the men to the "safety first" idea, and to prepare them for the organization of sub-safety committees, so that this movement will receive their full co-operation; at the same time impressing upon them the fact that the management considers this important work. Such sub-committees are to be organized in each department wherever a safety committee can be of use. All members of the central safety and sub-safety committees will have an official safety committee badge, which is official recognition that they are actively engaged in this work, the particular object of the sub-safety committee being to prevent accidents.

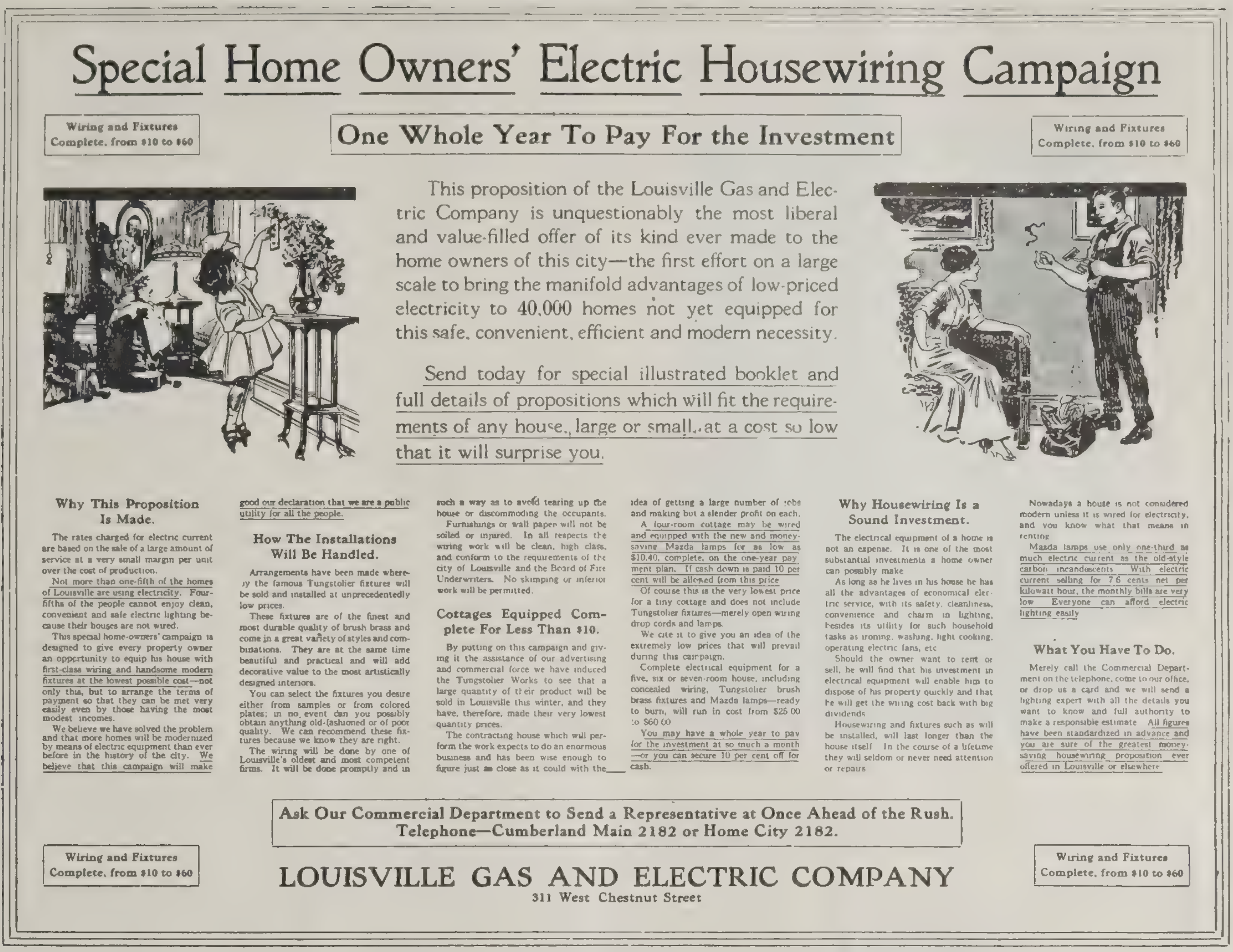
Members of the different sub-safety committees are to be appointed by the heads of their respective departments, and in each case a chairman designated. These sub-safety committees will hold regular meetings to investigate accidents that have happened in their departments or sections, and a written report turned in to the chairman of the sub-safety committee of that department, which in turn with report of action of sub-safety committee will be referred or forwarded to the secretary of the central safety committee.

COMMENTS FROM READERS.

Robert Montgomery, Manager Commercial Department of Louisville Gas & Electric Company, Louisville, Ky., Describes Home Owners' House-Wiring Campaign, Co-operation With Contractors, and Other Publicity Methods.

On December 7, 1913, the Louisville Gas & Electric Company started a house-wiring campaign, under the direction of E. L. Callahan, commercial manager of the H. M. Byllesby properties, to enable some 25,000 Louisville homes to provide for the use of electric service at a reasonable cost and liberal terms of payment. The proposition is explained in detail in the illustration presented herewith, which is a reproduction of a half-page newspaper advertisement which has been used by this company.

Liberal newspaper advertising of this type has been done during the campaign, the company furnishing all solicitors for securing the contracts. These contracts are turned over to local electrical contractors, who wire the houses, furnish the fixtures and take all the responsibility, assuming the accounts and making the collections. Since December 7 to date (March 6) house-wiring contracts amounting to $10,845.89 have been secured by our salesmen. On account of being busily engaged on other matters, we have hardly made a good start in this campaign, but expect to secure between 3,000 and 4,000 new customers



Special Home Owners' Electric Housewiring Campaign

Wiring and Fixtures Complete, from $10 to $60

One Whole Year To Pay For the Investment

Wiring and Fixtures Complete, from $10 to $60

This proposition of the Louisville Gas and Electric Company is unquestionably the most liberal and value-filled offer of its kind ever made to the home owners of this city—the first effort on a large scale to bring the manifold advantages of low-priced electricity to 40,000 homes not yet equipped for this safe, convenient, efficient and modern necessity.

Send today for special illustrated booklet and full details of propositions which will fit the requirements of any house, large or small, at a cost so low that it will surprise you.

Why This Proposition Is Made.

The rates charged for electric current are based on the sale of a large amount of service at a very small margin per unit over the cost of production.

Not more than one-fifth of the homes of Louisville are using electricity. Four-fifths of the people cannot enjoy clean, convenient and safe electric lighting because their houses are not wired.

This special home-owners' campaign is designed to give every property owner an opportunity to equip his house with first-class wiring and handsome modern fixtures at the lowest possible cost—not only this, but to arrange the terms of payment so that they can be met very easily even by those having the most modest incomes.

We believe we have solved the problem and that more homes will be modernized by means of electric equipment than ever before in the history of the city. We believe that this campaign will make good our declaration that we are a public utility for all the people.

How The Installations Will Be Handled.

Arrangements have been made whereby the famous Tungstolier fixtures will be sold and installed at unprecedentedly low prices.

These fixtures are of the finest and most durable quality of brush brass and come in a great variety of styles and combinations. They are at the same time beautiful and practical and will add decorative value to the most artistically designed interiors.

You can select the fixtures you desire either from samples or from colored plates; in no event can you possibly obtain anything old-fashioned or of poor quality. We can recommend these fixtures because we know they are right.

The wiring will be done by one of Louisville's oldest and most competent firms. It will be done promptly and in such a way as to avoid tearing up the house or discommoding the occupants.

Furnishings or wall paper will not be soiled or injured. In all respects the wiring work will be clean, high class, and conform to the requirements of the city of Louisville and the Board of Fire Underwriters. No skimping or inferior work will be permitted.

Cottages Equipped Complete For Less Than $10.

By putting on this campaign and giving it the assistance of our advertising and commercial force we have induced the Tungstolier Works to see that a large quantity of their product will be sold in Louisville this winter, and they have, therefore, made their very lowest quantity prices.

The contracting house which will perform the work expects to do an enormous business and has been wise enough to figure just as close as it could with the idea of getting a large number of jobs and making but a slender profit on each.

A four-room cottage may be wired and equipped with the new and money-saving Mazda lamps for as low as $10.40, complete, on the one-year payment plan. If cash down is paid 10 per cent will be allowed from this price

Of course this is the very lowest price for a tiny cottage and does not include Tungstolier fixtures—merely open wiring drop cords and lamps.

We cite it to give you an idea of the extremely low prices that will prevail during this campaign.

Complete electrical equipment for a five, six or seven-room house, including concealed wiring, Tungstolier brush brass fixtures and Mazda lamps—ready to burn, will run in cost from $25 00 to $60 00

You may have a whole year to pay for the investment at so much a month —or you can secure 10 per cent off for cash.

Why Housewiring Is a Sound Investment.

The electrical equipment of a home is not an expense. It is one of the most substantial investments a home owner can possibly make

As long as he lives in his house he has all the advantages of economical electric service, with its safety, cleanliness, convenience and charm in lighting, besides its utility for such household tasks as ironing, washing, light cooking, operating electric fans, etc

Should the owner want to rent or sell, he will find that his investment in electrical equipment will enable him to dispose of his property quickly and that he will get the wiring cost back with big dividends

Housewiring and fixtures such as will be installed, will last longer than the house itself In the course of a lifetime they will seldom or never need attention or repairs

Nowadays a house is not considered modern unless it is wired for electricity, and you know what that means in renting

Mazda lamps use only one-third as much electric current as the old-style carbon incandescents With electric current selling for 7 6 cents net per kilowatt hour, the monthly bills are very low Everyone can afford electric lighting easily

What You Have To Do.

Merely call the Commercial Department on the telephone, come to our office, or drop us a card and we will send a lighting expert with all the details you want to know and full authority to make a responsible estimate All figures have been standardized in advance and you are sure of the greatest money-saving housewiring proposition ever offered in Louisville or elsewhere

Ask Our Commercial Department to Send a Representative at Once Ahead of the Rush.
Telephone—Cumberland Main 2182 or Home City 2182.

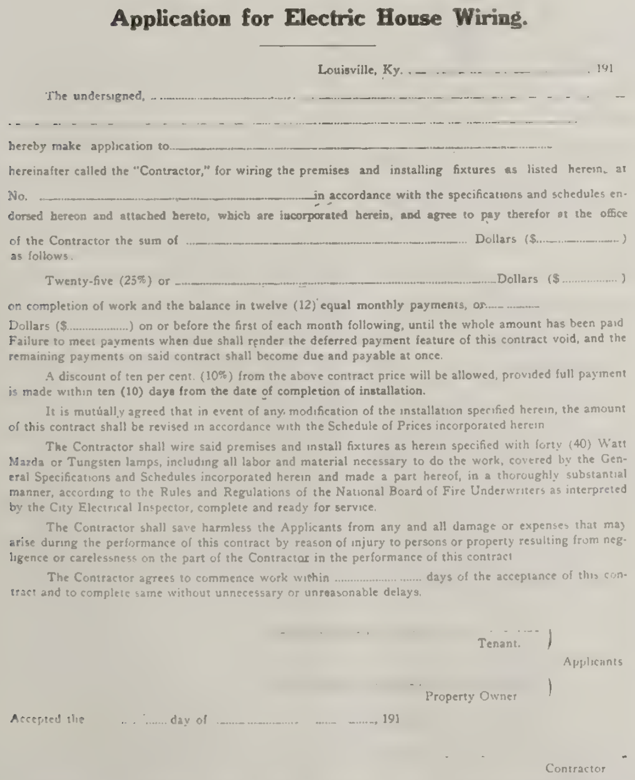
Wiring and Fixtures Complete, from $10 to $60

LOUISVILLE GAS AND ELECTRIC COMPANY

311 West Chestnut Street

Wiring and Fixtures Complete, from $10 to $60

FIG. 1. A NEWSPAPER ADVERTISEMENT USED IN HOUSE-WIRING CAMPAIGN.



Application for Electric House Wiring.

Louisville, Ky. 191

The undersigned, ...

....

hereby make application to ....

hereinafter called the "Contractor," for wiring the premises and installing fixtures as listed herein, at No. .... in accordance with the specifications and schedules endorsed hereon and attached hereto, which are incorporated herein, and agree to pay therefor at the office of the Contractor the sum of .... Dollars ($........) as follows.

Twenty-five (25%) or .... Dollars ($........) on completion of work and the balance in twelve (12) equal monthly payments, or .... Dollars ($........) on or before the first of each month following, until the whole amount has been paid Failure to meet payments when due shall render the deferred payment feature of this contract void, and the remaining payments on said contract shall become due and payable at once.

A discount of ten per cent. (10%) from the above contract price will be allowed, provided full payment is made within ten (10) days from the date of completion of installation.

It is mutually agreed that in event of any modification of the installation specified herein, the amount of this contract shall be revised in accordance with the Schedule of Prices incorporated herein

The Contractor shall wire said premises and install fixtures as herein specified with forty (40) Watt Mazda or Tungsten lamps, including all labor and material necessary to do the work, covered by the General Specifications and Schedules incorporated herein and made a part hereof, in a thoroughly substantial manner, according to the Rules and Regulations of the National Board of Fire Underwriters as interpreted by the City Electrical Inspector, complete and ready for service.

The Contractor shall save harmless the Applicants from any and all damage or expenses that may arise during the performance of this contract by reason of injury to persons or property resulting from negligence or carelessness on the part of the Contractor in the performance of this contract

The Contractor agrees to commence work within .... days of the acceptance of this contract and to complete same without unnecessary or unreasonable delays.

.... Tenant.)
Applicants
.... Property Owner)

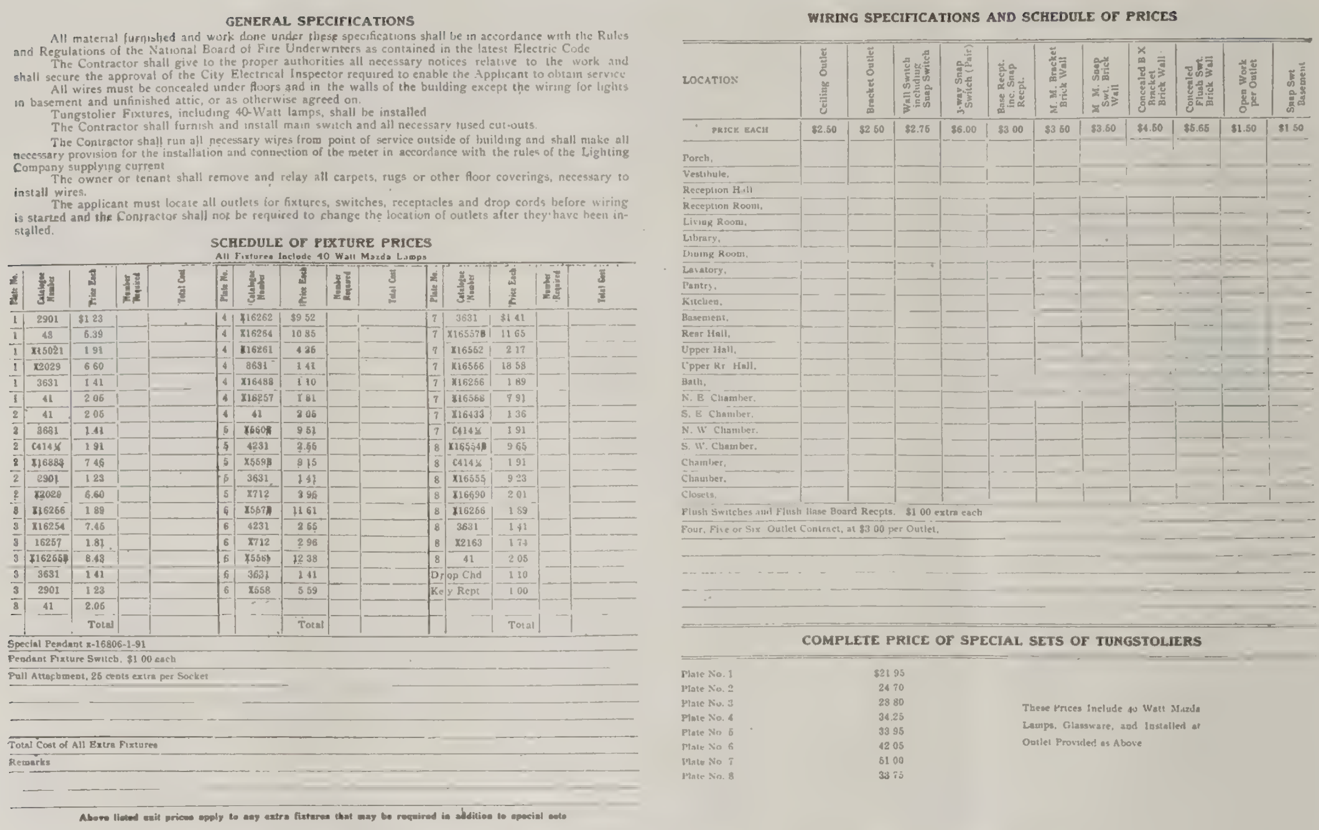
Accepted the .... day of 191

.... Contractor

FIG. 2. FORM OF APPLICATION FOR HOUSE-WIRING.

on this plan during 1914. The forms shown in Figs. 2, 3 and 4 give the nature of wiring contracts and the prices charged for the wiring.

The campaign has really been two advertising efforts in one, good will and commercial advertising copy being carried on simultaneously in the newspapers, the former introducing a new trademark and slogan of the company, and the latter covering the house-wiring campaign for new electric lighting business. The trademark consists of a flaming sun, on each side of which is a flaming torch. The name of the company is inscribed across the sun—the best possible interpretation of energy, which may be translated into either light or power. At the bottom of the trademark is the slogan "Your Partner," which was chosen by President Harries, of our company. *Printers' Ink*, the foremost American magazine devoted to advertising, recently had a description of the publicity methods inaugurated, and made the following comment: "By creating a trademark which is to be made an important part in all its publicity efforts, and by working out an interlocking campaign based on good will, and then turning to direct results, the company has played a few cards new to public service advertising; and, judging by results, they are trump cards. The advertisements are written in a serious, dignified and impressive manner." We believe this is a very flattering comment, yet it conveys an exact idea of what we are trying to do in Louisville, and, for that matter, in all cities



GENERAL SPECIFICATIONS

All material furnished and work done under these specifications shall be in accordance with the Rules and Regulations of the National Board of Fire Underwriters as contained in the latest Electric Code

The Contractor shall give to the proper authorities all necessary notices relative to the work and shall secure the approval of the City Electrical Inspector required to enable the Applicant to obtain service

All wires must be concealed under floors and in the walls of the building except the wiring for lights in basement and unfinished attic, or as otherwise agreed on.

Tungstolier Fixtures, including 40-Watt lamps, shall be installed

The Contractor shall furnish and install main switch and all necessary fused cut-outs.

The Contractor shall run all necessary wires from point of service outside of building and shall make all necessary provision for the installation and connection of the meter in accordance with the rules of the Lighting Company supplying current

The owner or tenant shall remove and relay all carpets, rugs or other floor coverings, necessary to install wires.

The applicant must locate all outlets for fixtures, switches, receptacles and drop cords before wiring is started and the Contractor shall not be required to change the location of outlets after they have been installed.

SCHEDULE OF FIXTURE PRICES

All Fixtures Include 40 Watt Mazda Lamps

Plate No.	Catalogue Number	Price Each	Number Required	Total Cost	Plate No.	Catalogue Number	Price Each	Number Required	Total Cost	Plate No.	Catalogue Number	Price Each	Number Required	Total Cost
1	2901	$1 23			4	X16262	$9 52			7	3631	$1 41		
1	43	6.39			4	X16264	10 85			7	X16557B	11 65		
1	X15021	1 91			4	X16261	4 26			7	X16562	2 17		
1	X2029	6 60			4	3631	1 41			7	X16566	18 58		
1	3631	1 41			4	X16488	1 10			7	X16256	1 89		
1	41	2 06			4	X16257	1 81			7	X16568	7 91		
2	41	2 05			4	41	2 06			7	X16433	1 36		
2	3631	1.41			5	X5608	9 51			7	C414X	1 91		
2	C414X	1 91			5	4231	2.55			8	X16554B	9 65		
2	X16883	7 46			5	X5598	9 15			8	C414X	1 91		
2	2901	1 23			5	3631	1 41			8	X16555	9 23		
2	X2029	6.60			5	X712	3 96			8	X16690	2 01		
3	X16256	1 89			6	X5578	11 61			8	X16256	1 89		
3	X16254	7.45			6	4231	2 55			8	3631	1 41		
3	16257	1.81			6	X712	2 96			8	X2163	1 74		
3	X16255B	8.43			6	X5566	12 38			8	41	2 05		
3	3631	1 41			6	3631	1 41			Drop Chd		1 10		
3	2901	1 23			6	X558	5 59			Key Rept		1 00		
3	41	2.06												
		Total					Total					Total		

Special Pendant x-16806-1-91

Pendant Fixture Switch, $1 00 each

Pull Attachment, 25 cents extra per Socket

Total Cost of All Extra Fixtures

Remarks

Above listed unit prices apply to any extra fixtures that may be required in addition to special sets

WIRING SPECIFICATIONS AND SCHEDULE OF PRICES

LOCATION	Ceiling Outlet	Bracket Outlet	Wall Switch including Snap Switch	3-way Snap Switch (Pair)	Base Recpt. inc. Snap Recpt.	M. M. Bracket Brick Wall	M. M. Snap Swt. Brick Wall	Concealed B X Bracket Brick Wall	Concealed Flush Swt. Brick Wall	Open Work per Outlet	Snap Swt Basement
PRICE EACH	$2.50	$2 50	$2.75	$6.00	$3 00	$3 50	$3.50	$4.50	$5.65	$1.50	$1 50
Porch,											
Vestibule,											
Reception Hall											
Reception Room,											
Living Room,											
Library,											
Dining Room,											
Lavatory,											
Pantry,											
Kitchen,											
Basement,											
Rear Hall,											
Upper Hall,											
Upper Rr Hall,											
Bath,											
N. E Chamber,											
S. E Chamber,											
N. W Chamber,											
S. W. Chamber,											
Chamber,											
Chamber,											
Closets,											

Flush Switches and Flush Base Board Recpts. $1 00 extra each

Four, Five or Six Outlet Contract, at $3 00 per Outlet,

COMPLETE PRICE OF SPECIAL SETS OF TUNGSTOLIERS

Plate No. 1	$21 95
Plate No. 2	24 70
Plate No. 3	28 80
Plate No. 4	34.25
Plate No 5	33 95
Plate No 6	42 05
Plate No 7	51 00
Plate No. 8	33 75

These Prices Include 40 Watt Mazda Lamps, Glassware, and Installed at Outlet Provided as Above

Figs. 3 and 4. Specifications and Schedule of Prices for Wiring Houses.

where the public utility companies are under the management of H. M. Byllesby & Co.

[Mr. Montgomery comes to the Louisville Company from the Fort Worth Power & Light Company, Fort Worth, Tex., where he has been responsible for building up one of the most successful commercial central station departments in Texas.—Editor.]

House Wiring Campaign at St. Louis, Mo.

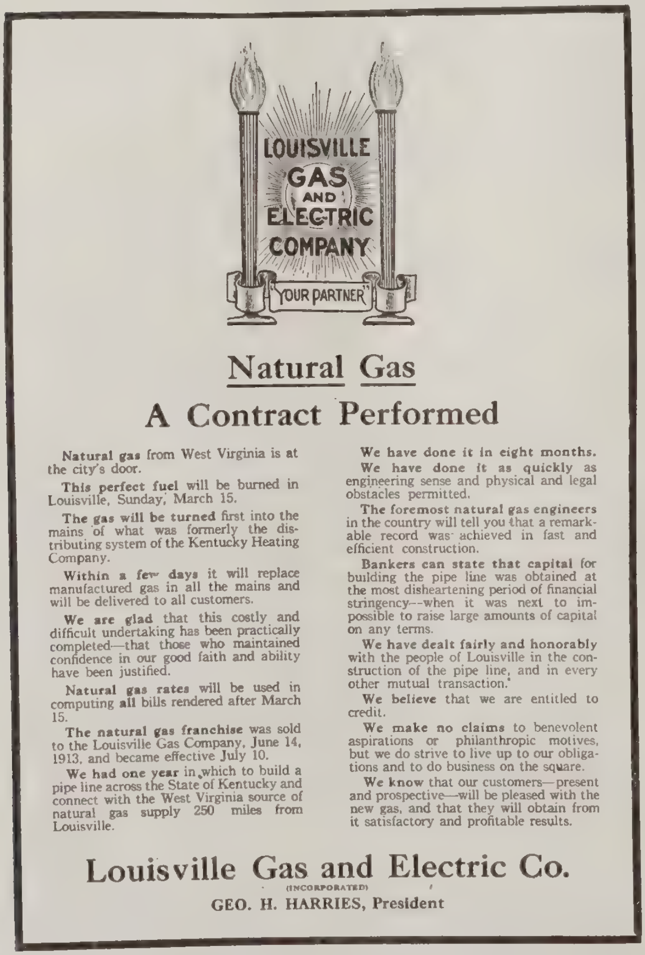
The Union Electric Light & Power Company, of St. Louis, Mo., has started a campaign whereby an opportunity is given non-users of electric light to have an "already-built" house wired at a small cost and on liberal terms of payment.

The accompanying schedule is arranged in a simple form, so that the cost of having a house wired can be estimated without the necessity of even the slightest knowledge of electricity or electrical terms. It gives all information as to the cost of the installation, which is done for 10 per cent of the actual cost paid upon the completion of same, and the balance paid in 12 monthly installments with bill for current.

PRICE SCHEDULE FOR WIRING ALREADY-BUILT HOUSES.

Wiring.

1.	One outlet in each of any two rooms on one floor, and, in addition thereto, one baseboard or wall outlet equipped with receptacle for electrical appliance attachment, ready for service connection	$17.95
2.	One additional outlet on next floor	7.00
3.	Each additional outlet on same floor with other outlets	2.00
4.	Each switch outlet with flush wall switch (single pole)	3.00
5.	Each two-circuit switch outlet with electrolier switch	4.50
6.	Each switch outlet with flush wall switch (combination 3 way)	4.00
7.	Each additional baseboard or wall outlet with receptacle for electrical appliance attachment	3.75
8.	One outlet in basement with switch on first floor (including flush switch)	5.00
9.	One outlet in basement of second floor apartment with switch on second floor (including flush switch)	10.00
10.	Each additional basement outlet on same switch	1.00
11.	Each drop cord with socket	1.00
12.	Each pendant switch	1.00
13.	Additional charge for wiring where there are double floors—per ceiling or floor outlet	2.00



Natural Gas

A Contract Performed

Natural gas from West Virginia is at the city's door.

This perfect fuel will be burned in Louisville, Sunday, March 15.

The gas will be turned first into the mains of what was formerly the distributing system of the Kentucky Heating Company.

Within a few days it will replace manufactured gas in all the mains and will be delivered to all customers.

We are glad that this costly and difficult undertaking has been practically completed—that those who maintained confidence in our good faith and ability have been justified.

Natural gas rates will be used in computing all bills rendered after March 15.

The natural gas franchise was sold to the Louisville Gas Company, June 14, 1913, and became effective July 10.

We had one year in which to build a pipe line across the State of Kentucky and connect with the West Virginia source of natural gas supply 250 miles from Louisville.

We have done it in eight months.

We have done it as quickly as engineering sense and physical and legal obstacles permitted.

The foremost natural gas engineers in the country will tell you that a remarkable record was achieved in fast and efficient construction.

Bankers can state that capital for building the pipe line was obtained at the most disheartening period of financial stringency—when it was next to impossible to raise large amounts of capital on any terms.

We have dealt fairly and honorably with the people of Louisville in the construction of the pipe line, and in every other mutual transaction.

We believe that we are entitled to credit.

We make no claims to benevolent aspirations or philanthropic motives, but we do strive to live up to our obligations and to do business on the square.

We know that our customers—present and prospective—will be pleased with the new gas, and that they will obtain from it satisfactory and profitable results.

Louisville Gas and Electric Co.
(INCORPORATED)
GEO. H. HARRIES, President

Fig. 5. Trademark and Slogan of Louisville Gas & Electric Company.

Fixtures With Glassware as Shown by Catalogue.

14.	One light fixture No. U101	$ 2.15
15.	One light fixture No. U101A	2.15
16.	One light fixture No. U200	1.80
17.	One light fixture No. U200A	1.35
18.	One light fixture No. U200B	.75
19.	One light fixture No. U201	1.80
20.	One light fixture No. U201A (with chain pull sockets)	1.60
21.	One light fixture No. U301 (combination)	2.60
22.	Two light fixture No. U202	4.25
23.	Three light fixture No. U203	5.45
24.	Four light fixture No. U204	6.65
25.	Two light fixture No. U302 (combination)	5.50
26.	Three light fixture No. U303 (combination)	7.35
27.	Two light fixture No. U102	3.90
28.	Two light fixture No. U102A	3.70
29.	Three light fixture No. U103 (all lights around)	5.40
30.	Four light fixture No. U104 (all lights around)	6.70
31.	Four light fixture No. U104A (all lights around)	9.75
32.	Five light fixture No. U105A (4 lights around, in center)	11.25

All fixtures (except No. U201A) are furnished with key sockets. Above prices do not include: Capacity of lighting outlets in excess of an average of 100 watts per outlet nor 660 watts per circuit; outlets on fireproof walls or floors; lamps.

George H. Wygant, Commercial Agent of Tampa Electric Company, Tampa, Fla., Installs Large Sign.

A rather unique roof sign has been installed by the Tampa Electric Company over newly equipped offices and display rooms. This sign is shown in the accompanying illustration, and is 33 by 38 feet. The words "Tampa Electric Company" burn steady in 30-inch letters. The other words are made up of 24-inch letters and flash during the operation of the outlined figures as follows: The generator at the right first appears with rotor revolving, causing the electricity to seem to flow up the wires at the right when the word "power" comes on. The current seems to flow toward the street car, and, upon reaching same, the windows appear to light up as if lighted from within. The outline of the street car burns steadily. The flow of current continues from the car through the wires at the left, around to the house, which also burns steadily in outline, and lights up as the flow of current reaches it. At the same time the word "light" shows up, together with "heat." The word "railway" flashes on as the car lights up. The entire sign presents a very beautiful, spectacular lighting effect, which works out in a real and natural manner. The design and sign itself were furnished by the Greenwood Advertising Company, of Knoxville, Tenn.

New Tampa Roof Sign.

Questions and Answers from Readers

Readers are invited to make liberal use of this department for discussing questions, obtaining information, opinions or experiences from other readers. Discussions and criticisms on answers to questions are solicited. However, editors are not responsible for correctness of statements of opinion or fact in discussions. All published answers and discussions are paid for.

DESIGN OF CHAIN DRIVE FOR MOTOR.

Editor Electrical Engineering:

(445) The writer would like to secure some data in the shape of a table or set of curves which will enable one to select the nature of a chain drive for a motor application where the speed of the driven shaft, speed of motor and horsepower to be transmitted only are required. A case as follows came up: A series of cotton gins were installed calling for a 50 Hp., 1,200 Rpm. 3-phase motor. The gins operate at 900 Rpm., and were so located that belts could not be used, but plenty of room for use of a chain. The problem run into was the securing of enough data on a suitable chain drive to estimate its cost in comparison with belts. If the latter were used, the conditions compelled a length of belt to cost about $150. In giving the above data, kindly show its application to this problem and give some method of estimating cost of gears to be used with the chain, and the smallest diameter of pinion for motor at different speeds. J. S. McD.

ACTION OF A CONDENSER.

Editor Electrical Engineering:

(446) Please request that some reader explain the action of a condenser in the Questions and Answers columns. I am advised by some that the current flows from one plate through the dielectric to the other plate, while others say the current surges in and out of one plate, producing a charge on the other plate. What is meant by the current surging, and how can there be a flow of current in a circuit containing a condenser when the circuit through the condenser is not closed through a metallic medium?

H. A.

MEASUREMENT OF POWER IN UNBALANCED CIRCUIT.

Editor Electrical Engineering:

(447) The writer has an ammeter connected to a three-phase circuit as shown in the accompanying sketch. The load consists of power and lighting and is unbalanced. The primary voltage is 2,300. Please advise if it is possible to calculate the actual load from the following readings: With switches (1) and (2) connected at (4), the ammeter reads 40; with switch (2) connected at (4), and switch (1) connected at (3), the ammeter reads 11; with switch (1) connected at (4) and switch (2) connected at (5), the ammeter reads 38. Can the power factor also be determined from these readings? B. B.

NATURE OF AN INDUCED CURRENT.

Editor Electrical Engineering:

(448) Kindly advise if all induced currents are alternating, and, if not, in what circuits and machines they may be direct. A. D. B.

ARMATURE WINDING FOR RAILWAY MOTOR.

Editor Electrical Engineering:

(449) The writer would appreciate a description and diagram from some reader of the armature winding of a General Electric type 205, inter-pole, 75 Hp. railway motor. B. S.

CONVERTERS AND FREQUENCY CHANGERS FOR LABORATORY USE.

Editor Electrical Engineering:

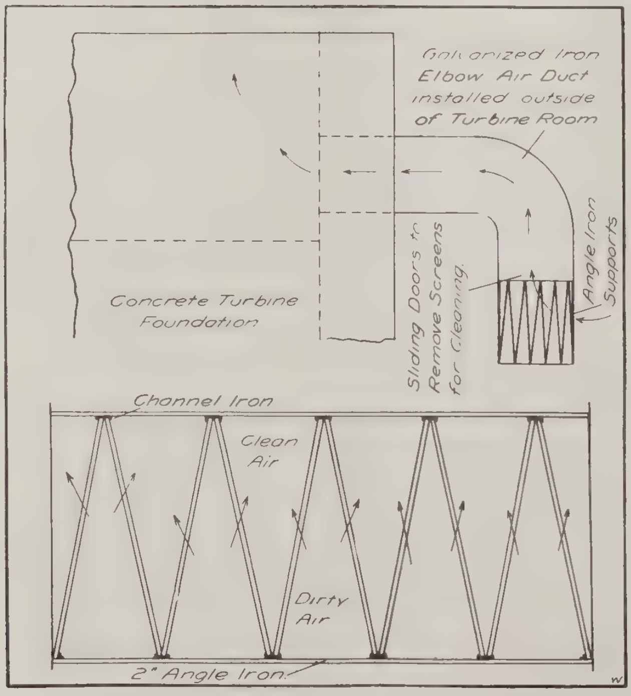
(450) As a subscriber and reader of *Electrical Engineering,* I desire to ask other readers through your columns for information on practical methods for transforming direct to alternating current, or vice versa, for experimental laboratory work, using voltaic or storage batteries and ordinary house lighting D.C. or A.C. supply of 110 volts, 60 cycles. Also give suggestions for simple devices for changing the frequency from 60 to 25 cycles, etc. The Standard Handbook describes a synchronous converter (rotary converter) as a means of converting an alternating to a direct current, or vice versa. Are there cheaper devices suitable for short time experimental work? Give names of companies who make small laboratory synchronous converters. Also, can small frequency converters be purchased for laboratory equipment, and, if so, from whom?

Experimenter Wireless.

Removing Dust From Cooling Air for a Turbine. Ans. Ques. No. 418.

Editor Electrical Engineering:

In answer to question 418, the writer presents sketches of a device for cleaning cooling air for a turbine. I have used this scheme for over two years, and find it satisfactory, even with the fine jute dust we have to contend with. We clean our screens twice a week, and, no matter how much rain or snow, the cooling air is always dry. Without the cheese-cloth over the wire net, this would not be so. We are operating a 2,500 ampere machine at 3,000 and sometimes 3,200 amperes, with the cooling air taken through this style of intake, and have never had to clean out the machine.


Galvanized Iron Elbow Air Duct installed outside of Turbine Room
Angle Iron Supports
Sliding Doors to Remove Screens for Cleaning
Concrete Turbine Foundation
Channel Iron
Clean Air
Dirty Air
2" Angle Iron
W

Screens for Cleaning Air for a Turbine.

The sketch shows the screens with the cleaning doors open. These screens are made up of 7/8 inch by 3 inch wood about 4 feet long and 3 feet high. Galvanized net is tacked on the wood frame of 1/4 or 3/8 inch mesh, and over this cheese-cloth. Clyde A. Turner (Mass.).

Light Absorption of Glassware. Ans. Ques. No. 421.

Editor Electrical Engineering:

In what follows the writer gives some data in answer to question 421. The figures represent results secured in an illumination laboratory for light absorption of glassware, as follows:

Alabaster Globe (milk white in color)	47 per cent
Heavy Opal Globe (bluish white in color)	45 per cent
Light Opal Globe (light bluish white, transparent)	27.7 per cent
Clear Globe, average when in fairly good condition	10.2 per cent

These absorption percentages were taken on globes designed for G. E. flame arc lamps, but I believe that the values of glassware used on ornamental incandescent lighting will not vary far from the above. The figures represent the average of several tests on each globe, and will vary in individual globes as much as 5 per cent in either direction—that is, from about 42 to 52 per cent for the alabaster globe.

It is the opinion of the writer that the heavy opal globe would have to be used in order to prevent the filament of the lamp from being seen under the conditions stated in the question. Glassware somewhere between the heavy and light opal globes might, however, be found which would answer. V. A. Clarke (Ohio).

Light Absorption of Glassware. Ans. Ques. No. 421.

Editor Electrical Engineering:

In answer to question 421 of the February issue, in reference to light absorption of glassware, although the question of absolute absorption is of relatively less importance than certain other factors, still it does form one basis of comparison, and a high output is usually a decided advantage. In such classes of service as street lighting, low absorption is a primary requirement, especially in the case of pure diffusing globes, which have no essential redirecting properties. Although your correspondent asks primarily about street lighting glassware, he may be interested in the

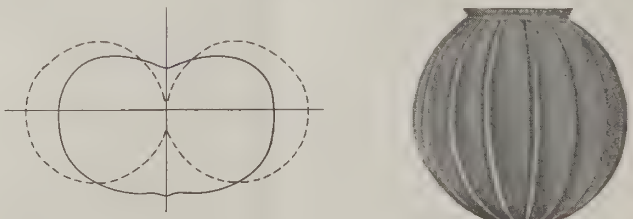


Fig. 1. A 12-Inch Blown Opal Ball and Distribution With a 100 Watt Lamp.

general study of the "Characteristics of Enclosing Glassware" covered by Mr. V. R. Lansingh in a paper read at the last annual convention of the Illuminating Engineering Society. A copy of this paper can be secured by writing to the secretary of the society at New York City. It includes much data on two types of glassware in considerable use in ornamental street lighting systems—namely, the blown opal glass shown in Fig. 1 and the ordinary ground glass, the distribution for each type being shown herewith. The absolute absorption in the case of the opal ball is 13.6 per cent and in the case of the ground glass 9.7 per cent.

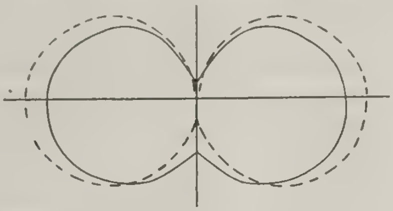


Fig. 2. Distribution From a 12-Inch Ground Glass Ball With a 100 Watt Lamp.

The writer believes that it is inadvisable, if not quite impossible, to define the density of such glassware in terms of the visability of the lamp filament at any certain mounting height or distance. There is too much "personal equation" involved in a definition of that sort.

E. B. Rowe,
Chief Illuminating Engineer, Holophane Works of G. E. Company (Ohio).

Light Absorbed by Glassware. Ans. Ques. No. 421.

Editor Electrical Engineering:

The table given below shows the coefficients of absorption for different classes of glassware, being the averages of experiments by numerous authorities. Only the most common classes in use are given, and the candle feet secured from any light source with any of these classes is found as follows:

$$\text{Candle Feet} = [CP \times 1.00 - C] \div N^2.$$

In this formula, CP is candle power of the light source, and N the distance from this source to any point illuminated on a horizontal plane below, with C the coefficient of absorption of the glassware used. C should be used in the formula as a decimal.

TABLE I. COEFFICIENTS OF ABSORPTION.

Clear Glass	5 to 10 per cent
Prismatic Glass	10 to 20 per cent
Lightly Obscured	20 per cent
Heavily Obscured	30 to 50 per cent
Dirty, Smooth Glass	5 to 15 per cent
Dirty, Frosted Glass	10 to 20 per cent
Dirty Prismatic Glass	15 to 30 per cent
Enameled Reflectors	20 per cent
Light Yellow Glass	15 to 20 per cent
Deep Colors	80 per cent

G. L. McLean (Canada).

Coughing in a Storage Battery Room. Ans. Ques. No. 422.

Editor Electrical Engineering:

In reply to the question by Mr. Lopez in the December issue, will say that if he will use a good grade of paraffin oil on top of his storage cells when he sets them up, just previous to the charging, all traces of fumes are so materially obliterated that there will be no cause for coughing or sore eyes. The oil should be spread over the entire top of the liquid so as to be about one-sixteenth or one-thirty-second of an inch thick. When cleaning time comes the oil can be slowly poured into a separate vessel, and the electrolyte into another, so that both can be used again. This is about as simple and as efficient a method as the writer knows of, and has found it very satisfactory in practice. It is essential that the ventilation is good if this scheme is used.

J. B. Dillon,
First Ranking Wire Chief, Western Union Telegraph Company (Texas).

Series Transformer on Open Circuit. Ans. Ques. No. 424.

Editor Electrical Engineering:

In answer to question No. 424, "Why does a series transformer on open circuit burn up?" the writer offers the following: A series transformer derives its name from the method of operation—*i. e.*, in series with the line. The voltage across the secondary on open circuit is a factor of the drop across the primary and the condition of the current in the main circuit. With full load current flowing in the primary and the secondary on open circuit, the transformer iron is worked at a high saturation because there is no counter flux to oppose it. All the flux is available to produce a potential in the secondary, which is equal to the primary drop times the number of turns in the secondary. The resultant voltage is excessive and causes a break-down between turns, tending to destroy the transformer.

When the transformer is short-circuited through an ammeter or by a wire, the potential generated in the secondary causes a current to flow, which sets up a counter flux, which tends to oppose that of the primary. A condition results so that there is just sufficient voltage in the secondary to produce the necessary effective current.

E. S. (New York).

Why Series Transformer on Open Circuit Burns Up. Ans. Ques. No. 424.

Editor Electrical Engineering:

On alternating current circuits, where voltages are not too high, and the currents are low enough, the various devices, such as ammeters, relays and coils of watt meters and watthour meters are connected directly in circuit. If the current is too large, or if the voltages are so high as to make it too dangerous to lead them directly into the instruments, use is made of a current transformer. Shunts same as are used on d.c. circuits cannot be used, as the self-induction of instrument coils will not permit the current to divide proportionally. As its name implies, its primary is connected in series with the circuit, while the secondary terminals are connected to the device to be operated.

In the design of a series transformer the prime object is to maintain a definite and uniform ratio of primary to secondary amperes. When used in connection with the series coils of a watt meter it is also necessary that the current in the secondary be in phase with the primary current as much as possible. To do this the excitation and core loss are reduced to the lowest possible value by having a low impedance and working the iron core at very low flux densities, the usual value being about one-tenth of the magnetic density used in shunt transformers.

When the secondary circuit is closed through a meter or any other device it is intended to operate, the current creates a magnetomotive force in a direction opposite to that created by the primary circuit. This limits the flux in the core to a value just sufficient to generate an e.m.f. in the secondary winding that will cause a current to flow in the secondary having a somewhat lower magnetizing effect than the primary current. The consequence is that, should the secondary winding be left open while current is flowing through the primary, there is no opposing magnetomotive force to limit the flux through the core. It therefore reaches a comparatively high value and a correspondingly high voltage long before the core becomes saturated, even with a small primary current flowing. This voltage is so entirely out of all proportion to the normal that the insulation is destroyed, endangering life and ruining other apparatus.

P. Justus (Ohio).

Why Field of Large D. C. Motor Should Not Be Opened While in Operation. Ans. Ques. No. 426.

Editor Electrical Engineering:

The reason that a shunt motor burns up or runs away when its field is removed is as follows: The drop across the armature is made up of two components, the smaller one being the RI drop in the copper, and the remainder being the back Emf. generated in the armature coils by cutting the field flux. This Emf. depends on the speed, field strength and the number of armature turns. Since the armature turns remain constant, we may write $E = KSF$, where K is a constant, S speed of motor and K the flux in the field. If the field is taken off the motor while in operation, F will drop to the value of the residual field, which is very small; so to keep the value of the back Emf. up to normal, the speed must increase greatly. If the machine is running free, this will be the case, and the motor will speed up until it flies to pieces. If it is loaded, it will not be able to speed up, due to torque having dropped with the field, and the result will be practically a short-circuit through the motor, burning it up if the breaker is not thrown.

A series motor runs away when its load is removed for practically the same reason. Series motors are designed to run at a given speed when drawing full load current through the field, as when loaded. When the load is removed the machine speeds up, increasing the back Emf., and consequently reducing the armature current and field strength. This causes the motor to speed up still more, to bring up the back Emf., which has dropped with the field, and the result is that the machine runs away. Since a series motor does not draw heavy current when this occurs, it will not throw the breakers, and is apt to fly to pieces unless the circuit is opened in time or is automatically opened by some speed-limiting device on the motor.

Nature of a Magnetic Blowout. Ans. Ques. No. 427.

The magnetic blowout depends for its operation on the principle that a wire carrying current is pushed sidewise when it is placed in a magnetic field. The coil used to blow out the arc may be shunted across the breaker with which it is to be used, or in some cases it may be in series with the breaker. It must be so placed that it will establish a magnetic field in the neighborhood of the arc. The arc is put out as follows: The side-push of the magnetic field on the arc increases its length and also its resistance. The increased resistance decreases the current, which, in turn, further increases the resistance. These two effects act cumulatively until the arc is extinguished. If properly constructed, the magnetic blowout should be equally effective on both A. C. and D. C.

Connections for 220 and 440 Volt Motors From Delta Transformer Connections. Ans. Ques. No. 431.

The voltage relations with 440 volt transformers in delta are as shown in Fig. 1, which is lettered according to the diagram given in the question. The instructions given to connect to A-4 and 5 were not correct, as the above diagram shows that the voltage between A and 5 is $\sqrt{3}$ times 220 volts, or 378 volts. While the motor would start and apparently operate satisfactorily when connected in this way, it would be very apt to overheat.

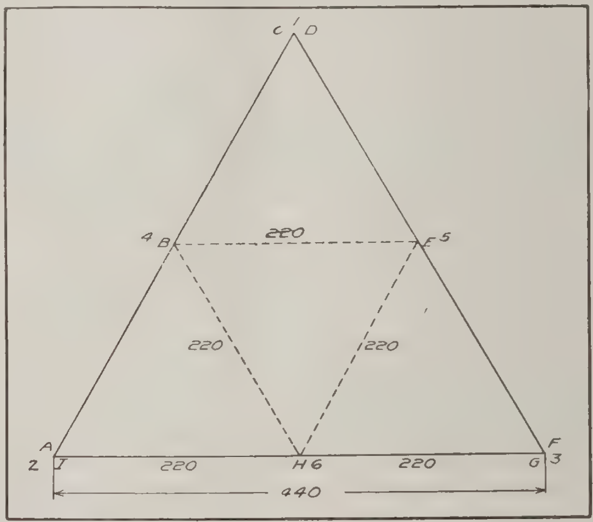


Diagram Showing Relations When Connecting 220 and 440 Volt Motors to Delta Transformers.

There are four possible ways of connecting that might be used for operating a 220 volt, 3 phase motor from a delta connected bank of 440 volt transformers. They are, from the above diagram, A–B–H, B–C–E, E–F–H, and B–E–H. Any of these connections will give a balanced 3 phase supply to the motor.

There is no objection to using motors in this way, provided the motor is small in comparison with the capacity of the transformers. Always bear in mind that the current carrying capacity of the coils must not be exceeded. If several small 220 volt motors are to be operated at once, it might be advisable to connect part of them to A–B–H, part to B–C–E, and part to E–F–H, and thus use the transformer capacity to better advantage. Where one medium-sized motor is used, probably the best connection would be to B–E and H.

F. J. Rankin (Colo.).

Opening Field of Large Motors. Ans. Ques. No. 426.

Editor Electrical Engineering:

In answer to question 426, by W. A. B., in the January issue, I would say that the breaking of the field circuit of a shunt wound direct current motor destroys its counter emf. This counter emf. is the voltage generated in the armature that opposes the current flowing through the armature. As a motor is rotated by the effects of the reaction between the field and the armature, it is evident that by the destruction of this counter emf. all opposition to the line voltage is removed. As direct current armatures are usually of low resistance, this practically forms a short circuit through the armature, allowing an enormous current to flow, causing the brushes to flash over and destroy themselves if the cut-out does not open promptly. Also the opening of the shunt circuit is liable to set up such a high induced emf. in the field windings that there is danger of puncturing or breaking down the field insulation.

In the case of the series motor dropping its load, it is a well-known fact that the speed of a series motor is proportioned to the load applied, the speed increasing as the load is decreased, and vice versa. As the load is reduced, the armature speeds up, the counter emf. increases, and the current rapidly decreases.

Now, the field is in series with the armature, so that as the current decreases the field strength also decreases, and the armature has to run still faster to generate its counter emf., which, at no load, is just about equal to the voltage between the mains. The current necessary to supply the losses is usually very small if the motor is well designed; consequently the no-load current is very small, and the speed necessary to generate the counter emf. becomes excessively high. In many cases this speed might be high enough to burst the armature. On account of this tendency to race, it is not safe to throw the load completely off a series motor unless there is some safety device for automatically cutting off the current.

Alex. R. Knapp (Ky.).

And Why Not Open Field of Motor in Operation? Ans. Ques. No. 426.

Editor Electrical Engineering:

In answer to question No. 426, by W. A. B., it must be remembered that when the field of a shunt wound motor is opened the counter emf. is destroyed. There is then no opposition to the line emf., and a short circuit is formed through the armature, which, being of low resistance, permits the flow of such an excessive current as to destroy it. In a series wound motor, the breaking of the field will stop the motor and cause no damage aside from probably burning a hole in whatever happens to be near the break.

In a compound wound motor, if the shunt field is opened, the series coil opposed to it brings the motor to a stop and starts it up in the reverse direction. Whenever a motor flashes over at the brushes, there is something wrong, and the motor should be stopped at once and examined. If the brushes are making good contact and not covering too much armature circumference, the following examination should be made: Move the rocker arm back and forth until the point of least sparking is found. Wipe the commutator clean, and, if the motor continues to spark, test for the following trouble: See that the commutator is true, and that the commutator does not act eccentrically toward the bushes from an uneven shaft bearing. The trouble may be due to a coil of the armature being short-circuited, when half the armature current is broken every time the commutator bar connected to the broken coil passes from under a brush. Also the motor may have weak fields, which may arise from a short circuit in the field coils or from two or more grounds between the field coils and the pole pieces. Again, the machine may be overloaded or the armature wires may be open-circuited.

When a series motor runs light (without a load), enough energy will be taken from the line to make up the friction, core losses, etc. As the speed increases, the counter emf. increases and the current decreases. Since the fields are in series with the armature, as the current decreases the field strength weakens, allowing the armature to speed up more rapidly to generate a counter emf. about equal to the line emf. In the case of no load, as when the belt slips off a series motor, if the line is not opened up a speed will be gained such as to throw the armature into pieces. It is dangerous practice to use a series motor where such a case might happen.

John R. Shannon (Ill.).

Why a Series Transformer on Open Circuit Burns Up. Ans. Ques. No. 424.

Editor Electrical Engineering:

The writer submits the following in answer to questions 424 and 426, in the January issue: In a series transformer, the magnetic flux that the primary would produce in the core is limited by the secondary current, which opposes it. The primary ampere-turns are greater than the secondary ampere-turns by an amount just sufficient to produce the flux that generates the emf. to overcome the impedence of the secondary circuit. Now, if the secondary is opened, the opposing action of its winding is destroyed, and the flux rises to an amount determined by the reluctance of the magnetic circuit and the magneto motive force of the primary winding. These quantities are usually such that the core becomes saturated, or, at any rate, the density reaches a very high value.

This abnormal flux will not only induce a very high value in the secondary winding, which might puncture the insulation, but the greatly increased core losses at such a high density will soon overheat the transformer.

Why Not Open Field of Motor in Operation? Ans. Ques. No. 426.

In question 426, W. A. B. wishes to know why a D. C. motor will "flash over at the brushes and burn up" if the field is opened while the motor is running. The current flowing through the armature of a D. C. motor during normal operation is limited by the counter emf. of the motor, the ohmic resistance having a relatively small effect. In a given machine the counter emf. is proportional to the speed and to the field strength. In practice the counter emf. is smaller than the line emf. by an amount just sufficient to force the load current through the armature resistance.

Now, suppose the field circuit is opened. This destroys the counter emf., and the current that flows through the armature is limited only by its ohmic resistance. Since this is small, many times full load current will flow. If the motor is not at once disconnected from circuit, it will "burn out," and in many cases the destructive sparking attendant to commutating such an enormous current will lead to a "flashover."

In regard to the excessive speed of a series motor without load, the field winding being in series with the armature, the field strength depends on the load current. As the load is thrown off, the motor speeds up, causing the current to decrease, which, in turn, causes the weakening of the field. This causes the motor to speed up still more. This action is cumulative and the motor soon reaches a dangerous speed.

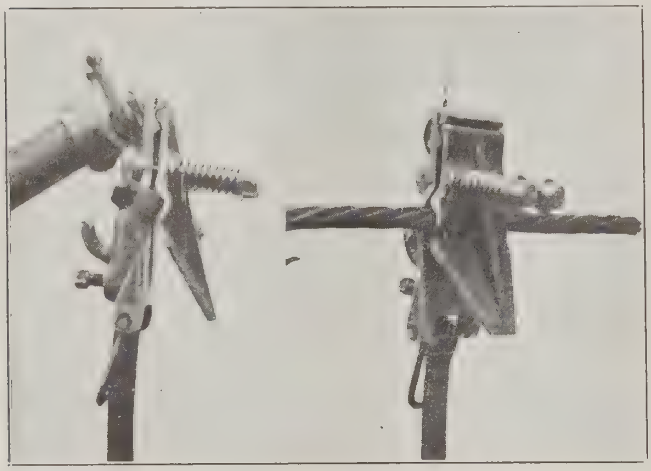
John H. Bledsoe (Ala.).

New Apparatus and Appliances

The Johnson Transmission Line Clamp.

The accompanying illustrations show a transmission line clamp designed by Mr. T. F. Johnson of the Georgia Railway and Power Company, Atlanta, Ga., and made and marketed by Hickey and Schneider, 227 Fulton St., New York City.

This clamp may be used for various purposes in connection with transmission line and substation operation. It is invaluable for use in sectionalizing transmission or pole lines, since for instance, a number of strain insulators may be placed in the line and one end of a jumper served onto the line on one side of these insulators. To the end of this jumper one of the Johnson clamps can be attached and snapped on to the conductor on the other side of the strain insulators. The line is then in condition to be sectionalized with practically no trouble whatever. In other words, the clamp when so used takes the place of a regular knife blade disconnecting switch and saves all the expense and inconvenience attendant upon the installation of such switches.



THE JOHNSON TRANSMISSION LINE CLAMP.

For connecting transformers in banks and disconnecting them therefrom, the clamp will soon pay for itself in time saved in such operations, as one transformer may be removed from a bank and repaired and then replaced in the bank without ever cutting off the power from the transformers, the two transformers carrying the load in open delta connection while the third one is being repaired. To do this it is only necessary to construct two dead busses on the high and low sides of the transformers and connect the transformers with these busses by means of the clamp. The customers service is in no way interrupted while this work is being done.

The clamp has also proved its value for connecting the two lines of a double circuit high tension tower line, thus jumping around line trouble even before the trouble is definitely located. It may also be used for cutting in service lines to main feeders without taking the power off the main feeders. Such work is at present being done on the Atlanta system while the feeders are alive.

When used in conjunction with a similar clamp for attaching to steel tower legs, the clamp also provides an efficient method of grounding lines, thus reducing the danger heretofore experienced in working on a line grounded in the old fashioned method by a chain. An instance is on record where one of these clamps was snapped onto a 110,000 volt live tower line without injury to the lineman who made the mistake, but of course with the natural result of knocking out the high tension system.

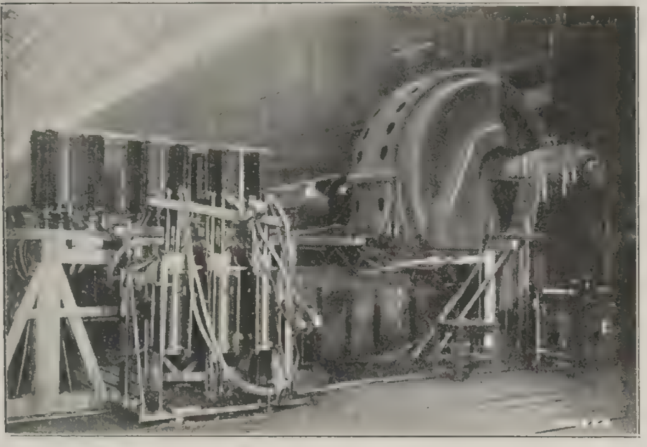
Under a test for current carrying capacity the clamp has carried over two hundred amperes at 440 volts over two hours with a temperature rise of only five degrees.

The clamp consists essentially of two brass castings, one known as the back carries an eye near the top and a hook about the center, with a loop at the bottom and a lug in which the wire lead to the clamp may be fastened by solder or gripped with a set screw. The front flap is held against the back flap by two bolts and springs, making a very simple and rugged construction as can be seen from the illustrations herewith. To use the clamp it is necessary only to catch a switch stick, specially designed for this purpose, in the eye of the clamp, place the clamp on the conductor to which it is to be connected, then insert the switch stick in the loop at the bottom of the clamp and pull downwards. The clamp quickly snaps onto the conductor. To remove it from the conductor, the switch stick is inserted in the eye at the top of the clamp and pushed upward, or pulled in any direction for that matter, as the clamp quickly adjusts itself in the direction of pull and comes off the conductor. A specially designed switch stick for placing the clamp on and removing it from lines has been made by the use of which there is absolutely no chance for the clamp to get loose from the stick during either operation.

Short-Circuit Test of a Large Westinghouse Generator.

In the presence of a number of representatives of central stations recently, the engineers of the Westinghouse Electric & Manufacturing Company deliberately short-circuited a 16,700 Kva., 8,800 volt generator, running at full speed, and without resistance or any other protection in the circuit. Oscillogram records showed that a current of 21,000 amperes, or 12½ times normal, flowed through the generator. With generators designed some years ago such a test would have wrecked the machine, but in the present instance no damage whatsoever was done. The only visible effect was a static flash between the field and the armature.

The test was performed to prove the fact that generators are being built that require no outside protection from outside short circuits, the generator itself being so designed as to be self-protecting. Unless the generator is properly constructed, a complete short circuit tears out the armature coils, which, coming into contact with the revolving field, causes extensive wreckage. Furthermore, the static flash, which always occurs under such circumstances, will destroy inferior insulation. With generators of the type tested, however, both results are guarded against by firmly securing the armature coils and bracing their ends on the one hand, and by the use of mica insulation on the other. In consequence, even so severe an ordeal as this test was withstood without harm, although it has been repeated many times with the same machine.



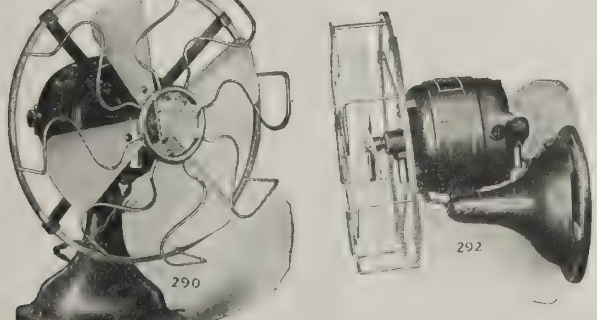
Westinghouse Generator Under Short-Circuit Test.

In connection with this test, several others were carried out in order to prove the reliability of circuit-breakers and reactance coils for protecting the feeder circuits. The generator was repeatedly short-circuited through these devices, which stood up admirably under the enormous stresses to which they were subjected.

The practice recommended by the Westinghouse engineers is to protect the feeders, and not the generators. If the generators are protected and a short circuit occurs on any of the feeders, even a poorly designed generator will not suffer, but the voltage will fall on all the feeders, all synchronous motors will be thrown out of step, and an overwhelming overload will be thrown on the circuit-breaker of the short-circuited feeder, since it will carry the total current of all the generators in the station. If, however, protective reactances are placed in each feeder circuit, and a short circuit in a feed occurs, only that feeder will be affected, and even then its reactance coil will prevent the current in it from rising to too high a value. The voltage will be maintained at the bus bars, and no disturbances will be felt in the remaining feeders. This happens, of course, provided that the generators are self-protective; if not, such an event may seriously injure them. It is possible to protect non-self-protecting generators by reactances, but, as the test described above shows, such a proceeding is unnecessary, since generators can be supplied that are immune to the worst conditions of load that can be imposed upon them.

New Robbins & Myers Eight-Inch Desk Fan.

The accompanying illustrations show a new 8-inch direct current desk and bracket fan developed by the Robbins & Myers Company, Springfield, Ohio, for the season of 1914. This fan is made for both 110 and 220 volt direct current circuits, and by means of a speed-regulating coil and switch in the base, three speeds can be obtained—1,700, 1,400 and 1,000 revolutions per minute. At these speeds the respective wattages are 25, 20 and 15 watts.



A New Robbins & Myers Fan.

A hinge joint provides for trunnion adjustment, adapting the fan for either desk or bracket service. The blades are made of the best grade sheet brass, and are riveted to a punched sheet carrier, which is formed to give a uniform pitch to all blades, the pitch being such as to give maximum air displacement with minimum power. A strong, durable guard surrounds the blades and is fastened to the body by four steel supports, which are fastened rigidly by screws. This guard is amply strong to permit the fan to be carried about by it without injury.

The frame and base of the motor are highly finished in baked black enamel, with fine gilt stripes. The blades are brushed brass finish and lacquered. In all details the fan is built strongly; it runs quietly and meets the needs of the home or office where larger fans are not desired.

Electrose Arcover Line and Strain Insulators.

A reliable line of suspension and strain transmission line insulators for all operating voltages has been produced by the Electrose Manufacturing Co., Brooklyn, New York, based on the inventions of Louis Steinberger, the president of the company. Mr. Steinberger is a pioneer in the design of high tension insulators, and has by years of eperimenting overcome many serious difficulties. The type of insulator shown in the accompanying illustrations is known as the "arcover" design with imbedded interlinking strain or suspension members made up of a single, integral and uniformly solid mass of insulating material without joints. Even though the insulating material should become totally destroyed, the line cannot possibly fall to the ground.

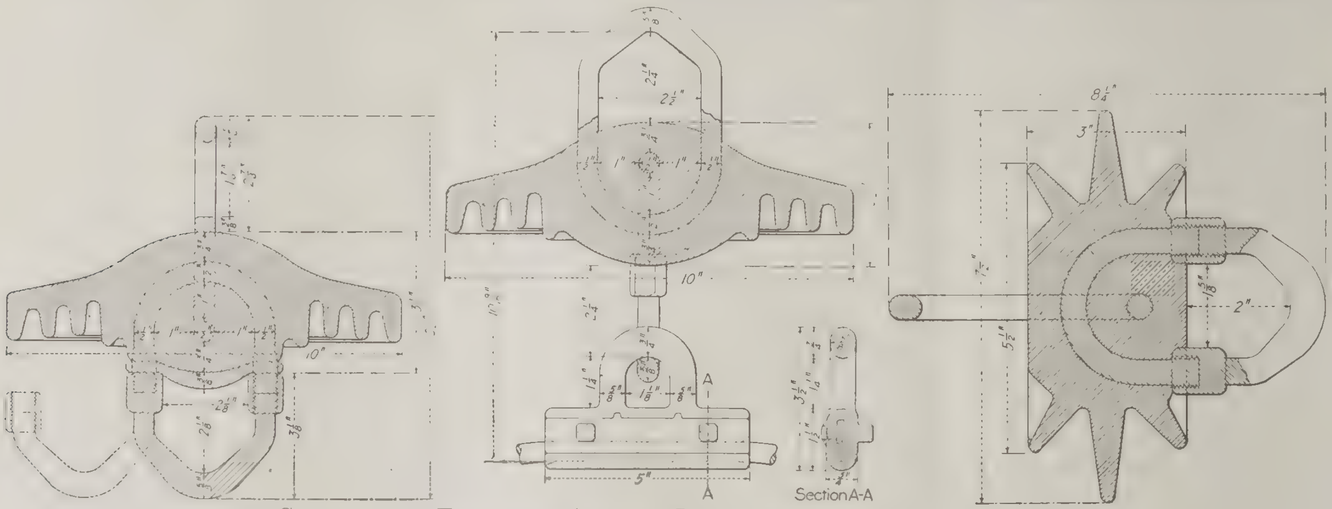
The electrical and mechanical values of these insulators are said to be worked out to a degree of perfection never before attained in this class of devices and are far in excess of ordinary requirements. Therefore they are especially well adapted for applications where unusually severe conditions prevail. These "arcover" insulators possess a number of original and desirable features. Two or more units may be connected or disconnected in a fraction of a minute, no special tool being required; a plain wrench, a nail or even a piece of wire is all that is needed. No extra connecting member is required and there are no loose parts to be lost. The spacing of the units in their relation to each other has been worked out on scientific lines, to the best possible advantage.

The novel form of line clamp shown in connection with the "arcover" insulators is also an invention of Mr. Steinberger, and possesses many admirable features. It has a smooth bore for gripping the wire or cable, thereby preventing crystallization and the possible breaking of the conductor at or near the clamp. It is designed so as to grip conductors of various diameters. It is light in weight, but sufficiently strong to break the conductor before slippage occurs. The metal parts employed in all these insulators are made of galvanized drop-forged steel.

In the table below are given the electrical and mechanical values of the 10-inch "arcover" disk suspension and strain insulators, also of the 7.5-inch "arcover" disk strain insulators:

	7.5-inch Disk Strain Insulator	Strain and 10-inch Disk Suspension Insulator
Puncture value, in oil	120,000 volts	150,000 volts
Tested to dry arc value	85,000 volts	100,000 volts
Rain arc value	55,000 volts	55,000 volts
Line voltage	25,000 volts	25,000 volts
Mechanical value	20,000 lbs.	20,000 lbs.
Tested to	10,000 lbs.	10,000 lbs.

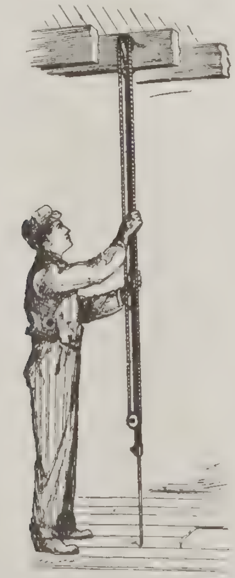
Arcover disk strain insulators are made in the following diameters: 5.5, 7.5, 10.5, 12.5 and 14.5 inches. Arcover disk strain and suspension insulators are made in the following diameters: 8, 10, 12, 14 and 16 inches.



Sections of Electrose Arcover Line and Strain Insulator.

Boring Machine for Electrical Contractors.

A chain drive boring machine, designed to bore holes through joist or studding from the floor above or below the operator, is being marketed by M. Rutkin, Newark, N. J. The nature of this machine is shown in the accompanying illustration, and is very convenient for boring holes in joist when wiring old houses, where it is important to take up as few floor boards as possible. It is claimed that many more holes can be bored with this machine in a day than with the ordinary breast drill used for this purpose.



Chain Drive Boring Machine.

Electrical Construction News

This department is maintained for the contractor, dealer, manufacturer and consulting engineer.

ALABAMA.

BIRMINGHAM. The Alabama Power Company is constructing a substation to cost approximately $125,000 to receive current from the Lock 12 development for distribution in Birmingham.

TUSCALOOSA. According to reports, the Birmingham, Tuscaloosa Railway & Utilities Company has issued $600,000 in bonds, the proceeds of which are to be used for the construction of a new central generating plant and gas holder and the extension of a street railway system.

FLORIDA.

MELBOURNE. The city is soon to construct an electric light plant. Bonds have recently been issued.

TAMPA. The Tampa Electric Company is to install two 520 horsepower high pressure boilers with stokers during the next six months. J. C. Woodsome is manager.

GEORGIA.

ALBANY. The Albany Power & Manufacturing Company is to install during the year a 750 Kw., 2,300 volt, 3-phase, 60-cycle turbo-alternator with complete condensing system. E. S. Killebrew is superintendent.

AUGUSTA. The Augusta-Aiken Railway & Electric Company, of Augusta, Ga., will purchase 4,000 Kw. in transformers, 300 irons and 200 cooking units, consisting of toasters, coffee percolators and other current-consuming devices, during the year. M. H. Hendee is contract agent.

BRUNSWICK. The Mutual Light & Water Company is to construct an electric light plant.

EATONTON. The Putnam Mills & Power Company is to construct a hydro-electric plant and enlarge its present plant to furnish light and power to the city and to the Putnam Mills. Lladshaw & Lladshaw are engineers, of Spartanburg, S. C.

HARTWELL. The Franklin Light & Power Company is reported to be contemplating the construction of steam generating plants in Hartwell to develop 5,000 horsepower. Forty miles of transmission line will be erected, at a cost of $50,000, connecting Hartwell, Lavonia, Conan, Bowersville and Royston, Ga.

MACON. The Central Georgia Power Company and the Central Georgia Transmission Company are to install additional generator capacity in the Jackson plant to increase the output to 24,000 horsepower.

METTER. The Metter Co-operative Light & Power Company has been organized, with a capital of $20,000.00 by J. R. Dickson, W. J. Brown, B. G. Bowen and others.

KENTUCKY.

MOREHEAD. The city will rebuild the electric light plant which was recently burned. E. E. Maggard is engineer in charge.

LANCASTER. Plans have been completed for a steam plant to cost approximately $10,000 by W. Zanone. The plant is owned by Alexander Walker and G. C. Rose.

NORTH CAROLINA.

HAZLEWOOD. The city has issued $15,000 in bonds for the installation of an electric light plant and waterworks. W. H. Cole is chairman of the finance committee.

MORGANTOWN. The city expects to purchase a second-hand 50 Kw., 3-phase, 2,300 volt generator for direct connection to an engine.

WARSAW. The city has contracted with J. W. Petty, of the East Carolina Light & Power Company to install an electric lighting system.

WILSON. The city is to make extensive improvements to its electric light plant, consisting of additional equipment, including boilers, turbines, condensers and switchboards.

SOUTH CAROLINA.

BENNETTSVILLE. The city will purchase a 200 Kw., engine-driven generating unit for a municipal electric light plant and a motor-driven turbine pump. E. C. Morrison is manager.

DENMARK. The Carolina Public Service Company, of Denmark, is installing an electric light plant and will purchase electrical supplies.

PERSONALS.

MR. BERTRAM SMITH, who started in the storage battery business in 1899 with the old National Battery Company, of Buffalo, and was secretary and treasurer for three years, has been appointed assistant manager of the Edison Storage Battery Supply Company, of San Francisco, which company handles the Edison battery on the Pacific coast. Since the absorption of the National Battery Company by the United States Light & Heating Company, Mr. Smith has been manager of the latter company's battery department in Chicago.

MR. E. C. DEAL, who for some time has been vice-president and general manager of the Augusta-Aiken Railway & Electric Corporation, has resigned as general manager of this company to accept an executive position with the banking house of W. N. Coler & Co., of 43 Cedar street, New York City. Mr. Deal still retains his interest in the Augusta companies as vice-president of the Augusta-Aiken Railway & Electric Corporation and vice-president of the Georgia-Carolina Power Company, and becomes vice-president and general manager of the North Carolina Public Service Company, controlled by W. N. Coler & Co., and including the public service properties at High Point, Spencer, Salisbury and Concord, N. C., as well as the Carolina & Yadkin River Railroad, which runs south of High Point a distance of about fifty miles. Mr. Deal took charge of these properties on February 1st, and for some time will be located at Greensboro, N. C., but later at 43 Cedar street, New York City.

Mr. Deal gained his early experience with the Georgia Electric Light Company, which he served in various capacities from 1894 to 1898. He then entered the employ of Stone & Webster, of Boston, Mass., and left them in 1904 to go with the Gas & Electric Company of Bergen County, in New Jersey, as chief engineer in charge of the company's properties in more than forty municipalities in Northern New Jersey. When that company was absorbed by the Public Service Corporation of New Jersey, Mr. Deal became superintendent of the electric properties in Central New Jersey. He severed his connection with the Public Service Corporation in 1908 to go with W. N. Coler & Co. as manager and engineer of public service properties owned by them. Following the acquisition of the property of the Augusta Railway & Electric Company and the Augusta-Aiken Railway & Electric Company by a syndicate in which J. G. White & Co., Inc., of New York City, were interested, Mr. Deal resigned from Coler & Co. to become manager of the Augusta-Aiken Railway & Electric Corporation, the successor company in Augusta. This was in April, 1911. In April, 1913, he was elected vice-president of the company in addition to general manager. Mr. Deal is fourth vice-president of the National Electric Light Association and is a past president of the Southeastern Section of the National Electric Light Association. In his new capacity he is in an excellent position to do much effective missionary work for this section, and has signified such an intention, which, based upon the results he has already accomplished as the organizer of the Southeastern Section, is certain to be a decided benefit to the association.

MR. W. S. MURRAY has been appointed consulting engineer, in general charge of all electrical engineering and construction of the New York, New Haven & Hartford Railroad Company, reporting to President Hustis, with offices at New Haven. Mr. Murray, following the substantial completion of the construction of the system for complete electrical operation west of New Haven, will enter into closer relations with the railroad company. His jurisdiction will hereafter be extended to also include the electrical features of operation in addition to electrical construction. He will continue with the firm of McHenry & Murray in general consulting practice as before.

MR. F. S. MONTGOMERY WILL GO TO PITTSBURGH, PA.

An important announcement comes to us as this issue goes to press, to the effect that Mr. F. S. Montgomery, manager of the Atlanta office of the National Metal Molding Company, of Pittsburg, Pa., has been appointed advertising manager of the company, with headquarters at Pittsburgh. Mr. Montgomery took charge of the Atlanta office of the company March 1, 1913, succeeding his brother, L. S. Montgomery, who was given charge of the Pittsburgh district, and with whom he had been associated since March, 1912. Under the Montgomery management the Atlanta office has assumed an important place in the sales organization of the company, the result of well-executed sales policies.

MR. F. S. MONTGOMERY.

The products of the National Metal Molding Company were introduced to the South four years ago by Mr. L. S. Montogmery, and while a good business was done during the first half of this period, during the past two years the sales have been more than doubled, and every important Southern jobber carries a complete stock of all the company's products. The state of Tennessee has recently been added to the territory under the Atlanta office, making its jurisdiction cover North and South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana and Tennessee. Mr. F. S. Montgomery advises that the company is soon to place on the market a full line of outlet and switch boxes in sherardized and enamel finish. About April 1st a hand book will be circulated among contractors which lists and describes the proper installation and assembly of all metal molding fittings.

Mr. Montgomery expects to take charge of his new work about April 1st. Mr. G. M. Stout, his assistant, has been appointed manager of the Atlanta office. The many friends of both these gentlemen, who are well known in a business and social way, extend, we are sure, good wishes for the greatest possible success in their new fields.

MR. H. F. MILLER has recently been appointed advertising manager of the Gould Manufacturing Company, of Seneca Falls, N. Y., manufacturers of the well-known Gould pumps. Mr. Miller comes to this company from the Otis Elevator Company, of New York City, where he was assistant to the advertising manager, and was responsible for the creation of copy suggestions and advertising plans. Previous to his connection with the Otis Elevator Company, he held a responsible position in the advertising department of the Western Electric Company for four years. In this position he established for himself a reputation for originality and for the presentation of strong "reason why" advertising copy. With the extensive experience which Mr. Miller has had in the creation of copy and the planning and execution of advertising campaigns on a large scale, it is certain that his new work will bear characteristic marks of his individuality and be of benefit to the sales efforts of his company. He is well known in the East among technical ad men.

D. R. SHEARER, consulting engineer, of Knoxville, Tenn., has been retained to design a 200 Hp. hydroelectric plant on the New River to supply power to the Appalachian Training School of Boone, N. C. The cost of the plant will be about $6,000. Bids for equipment will be received when specifications are complete.

MR. C. H. CLARK, formerly advertising manager of the Gould Manufacturing Company, has resigned to accept the position of advertising manager with the Robbins & Myers Company, of Springfield, Ohio. Mr. Clark is one of the pioneers in electrical advertising, having been one of the originators of the advertising of the Western Electric Company, and, together with H. M. Post, established for that company its first advertising department and the character of advertising which is being so successfully executed by the Western Electric Company today on an extensive scale. Mr. Clark's new position enables him to place into use a variety of advertising ideas, since his company manufactures an extensive line of small motors, fan motors, generators up to 15 Kw., motor generators, dynamotors, balancer sets, etc., and has agencies in all principal cities.

MR. W. C. DUNCAN, who has had charge of the central station at Bay City, Tex., for the Albert Emanuel Company, of Dayton, Ohio, has resigned to take up other work for this company. The results secured by Mr. Duncan at Bay City were outlined in the February issue of Electrical Engineering. Mr. Theodore Dieust, formerly manager of the Texas Public Service Company at Gilmer, Tex., succeeds Mr. Duncan at Bay City, and Mr. C. A. Bergen, of the same company at Mt. Pleasant, Tex., assumes charge at Gilmer in addition.

MR. D. WALKER WEAR, formerly purchaser of the Chicago Tunnel Company, has been elected vice-president and director of the Stow Mfg. Company, of Binghamton, N. Y., with offices at 443 State street.

MR. F. L. GOHL, Chicago representative of the Allen-Bradley Company, of Milwaukee, Wis., has moved his headquarters from 540 Commercial National Bank building to 307 Webster building, at 327 La Salle street, Chicago. This change was caused by increase of business such that the old quarters were too small.

A. JACKSON MARSHALL has been elected executive secretary of the Electrical Vehicle Association of America, with permanent headquarters at the United Engineering Society's building, 29 West 39th St., New York City. Mr. Marshall is one of the best known personalities in the Central Station field and it is felt that his knowledge of central station conditions; his well-known respect for broad, consistent development and equitable relationships, and his original and interesting method of obtaining results, will cause him to early prove a factor in the further success of the Electric Vehicle Association. During the last several months Mr. Marshall has been associated with the General Motors Truck Company, having been in charge of this company's business in Northern New Jersey, with offices with the Electric Garage Company at 123 Washington street, Newark.

MR. C. F. ZIEGLER, president of the Reynolds Electric Flasher Mfg. Co. of Chicago and New York, is making an extended trip through the South, taking in Cuba, Panama Canal, etc., combining business with pleasure.

GEORGE F. MADDOCK has recently been appointed manager of the department of examinations and reports of H. M. Byllesby and Company, Chicago. Mr. Maddock has had an exceptionally valuable experience in a wide variety of engineering work. He has been assistant professor of engineering at a prominent university, manager of several utility properties, has had the engineering designing and direction of a large amount of utility plant construction and for several years was works manager of a large steam engine manufacturing plant. The training of Mr. Maddock, including reporting and appraisal work, fits him admirably for the management of a department of examinations and reports, which is often called upon to investigate large enterprises and to make valuations which will withstand the most vigorous attack. Service offered by the department he now heads, is not confined to utilities operating in cities, but extends to steam and electric railways and manufacturing and industrial plants of all kinds.

INDUSTRIAL ITEMS.

MR. F. V. L. SMITH, manufacturer's agent, of 1206 Empire building, Atlanta, Ga., announces the following new lines and new features of those lines he already carries. Rigid Conduit, made by Central Tube Company, Pittsburgh, Pa.; Hard Fiber, made by Delaware Hard Fiber Company, Wilmington, Del.; Electric Fountains, made by the Electrc Fountan Company, 348 West 42nd street, New York City; and Hill Switches, made by Taunton-New Bedford Copper Company, Taunton, Mass.; and Triad Soldering Fluxes, Triad Company, Belmar, N. J. The line of electrical fountains is an interesting one, with types suited for installation in moving picture theaters and in the home. These fountains are complete in themselves, no water connections being required, since they operate by means of a motor and pump concealed in the base, and use the same water over and over. A number of New York theaters have installed these fountains, and Mr. Smith advises that they are being favorably received in Southern cities.

THE ESTERLINE CO., Indianapolis, Ind., manufacturers of curve drawing instruments, announce the opening recently of several additional branch offices under the following managers: F. C. Morton, Walker Bank building, Salt Lake City, Utah; G. W. Pieksen, Room D-19, Railway Exchange building, St. Louis, Mo.; J. S. Black, 908 Hennen building, New Orleans, La.; W. W. Geisse Company, McKnight building, Minneapolis, Minn.; General Supplies Ltd., 122 Eleventh avenue, W. Calgary, Alberta, Canada; G. L. Priest, 229 Sherlock building, Portland, Ore. These offices are equipped with an expert engineering staff, full set of samples, together with all information necessary for promptly taking care of any questions that may arise in connection with the sale or use of graphic instruments.

Greenwood Electric Signs

Individuality

(they're different)

A Bunch for South America

GREENWOOD ADVERTISING COMPANY

Knoxville, - - Tennessee

Western Factory at Los Angeles

THE WESTERN ELECTRIC COMPANY reports sales for the year 1913 amounting to approximately $78,000,000, an increase of some $6,000,000, or over 8 per cent over the 1912 sales of $71,727,329. In 1911 sales amounted to $66,211,975. Business in 1913 was pretty close to the estimate made at the beginning of the year. As a result of business activity and unusual conditions in the Middle West due to floods, orders in the early part of the year ran at a much higher rate than that shown for the full year, but in the latter half of the period business fell off very considerably. However, an increase in sales of over 8 per cent is no mean gain for the twelve months.

The company added upwards of 4,000 customers last year, bringing the number to approximately 36,000. The increase in business was quite general with customers of the various classes, sales being made to the Bell companies and telephone concerns outside of the Bell system as well as many thousands of customers for electric light supplies. The increase in business applies to central stations and also contractors, despite the decrease in building during the last year, but there was a slight falling off in the business with railways, a not unnatural development under the circumstances.

The export business of the Western Electric Company in 1913 was the largest in the history of the company, notwithstanding the conditions in Mexico.

To increased efficiency of the company's management, considering the unsatisfactory business conditions prevalent throughout the country during the latter part of last year, must be attributed considerable of the growth in the gross business of the company.

THE SIMPLEX MANUAL. The Simplex Wire & Cable Co., Boston, has issued a 92-page booklet, written to meet the needs of every electrical man who has anything to do with wiring problems. It is full of tables and other information of all sorts about insulated conductors and other matters electrical, and is equipped with an unusually complete index. Printed on a fine thin paper, and bound with stiff covers, the book is distributed gratis to those who ask for it.

AUTOMOBILE LIGHTING AND BATTERY CHARGING. —The Holtzer-Cabot Electric Company, Brookline, Mass., has issued a 12-page booklet illustrating and describing a magneto generator designed for automobile lighting.

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The Engineering of the Tallulah Falls Development.

During the latter part of September of last year, one turbine was placed in operation in the Tallulah Falls plant of the Georgia Railway & Power Company at Tallulah Falls, Ga. Work on this development, which is the highest head hydro-electric plant east of the Rocky Mountains, began in the fall of 1911, and continued without interruption for practically two years, the greater part of which time being consumed in the hydraulic construction to secure an operating head of 600 feet. As a development this one is the most interesting and unique, from standpoints of design and construction, of any yet built in the South, and is one of a very few of its kind to be constructed in this country. In point of capacity it is the largest yet in operation in the South, with the exception of the Lock 12 station, on the Coosa River, in Alabama, now under construction, with a provision for 81,000 Kva. generating capacity, as well as the next largest in point of ultimate possible capacity. From a hydraulic standpoint, the rating of this plant, as recorded elsewhere in this issue, is most conservative—probably more so than a similar rating for any other Southern development.

The development as a whole consists of a storage reservoir with a capacity of 1,400,000,000 cubic feet; a diversion dam six miles below on the Tallulah River, at Tallulah Falls proper; a special intake to a concrete lined tunnel 6,670 feet long through solid rock to a structural steel reinforced forebay and surge tank. From this surge tank five steel penstocks 1,200 feet long, 5 feet in diameter, with a provision for six, lead to a power house containing five 10,000 Kva. generators, with a provision for six, each driven by a 17,000 Hp. vertical shaft Francis turbine, operating under an average head of 600 feet. These units are among the largest installed in this country and have carried over 18,600 Hp. since being installed without perceptible heating of the generator. From this power house energy is transmitted over a double circuit steel tower transmission line at 110,000 volts to outdoor type substations located at Gainesville, Cartersville, Atlanta, Lindale and Newnan, Georgia.

The engineering in connection with the system possesses individual characteristics throughout. No money has been spared where permanency or safety as to mechanical details were concerned and where continuity of service through electrical details was involved. The generators were among the first water power machines to be specified with steel spiders of rolled steel plate—a caution against defects which may exist in steel castings, and an important safety factor in mechanical failure of a rotaing element at high speed which is sure to be serious in character. This is a real consideration when it is remembered that all water wheels are liable to attain runaway speed, and for one cause or another actually do run away at times. Further, the Tallulah Falls rotors with a flywheel effect of 1,250,000 foot pounds, are designed for a runaway speed of 1.7 times normal for one hour. Again, as a precaution against or in anticipation of unavoidable serious variations in electrical operating conditions, the generators are designed for an excitation of not more than 250 volts at 10,000 Kw. load, 80 per cent power factor, and generator voltage of 7,260, the normal voltage being 6,600. This excitation feature at 10 per cent rise in voltage makes possible an absolute control of generator voltage, even under the worst possible line condition, giving sufficient leaway so that voltage may be varied through a wide range of power factor, and increased without over-exciting the generator fields. This has been found a valuable consideration, since the generators operate at normal rating with practically no temperature rise, making it feasible to increase the normal rating of the machine if such should be necessary under average operating conditions.

All of the high tension wiring of the Tallulah switch house is by copper tubing, with bends made according to designed forms, and supported so as to give symmetry to the entire layout and a mechanical appearance that indicates permanency. Where the high tension lines leave this structure, instead of the usual high tension wall bushings with a covering to apologize for their efficiency, oil-filled 150,000-volt wall bushings of special design are used, requiring no outside covering, a consideration in advance of such construction when designed some two years ago.

In the design of the transmission lines, similar considerations may be found. Steel towers bearing two ground wires, and considerably heavier than those yet installed in the South, were specified, the idea being that the cost of some extra metal is much cheaper than even one failure if expressed in terms of effect on service.

For the telephone lines strung on the transmission line towers, No. 4 copper-clad wire was used primarily to enable a construction parallel to the power wires, and still be sure that the strength of same would be sufficient to stand sleet and wind, and at the same time hold the tower height to a reasonable figure. Since this telephone system has been installed, most exhaustive tests have been made on it, and oscillograph records which show actual inductive influence of power lines on same, as well as other effects, have been secured. This data is of a nature never before secured for an actual transmission system, and should greatly influence the design of future systems. This is another feature of interest in connection with the high character of engineering which the entire system represents.

The substation at Atlanta, further than being the largest one of its kind in the world, embodies features that are equally individual in character. Special attention has been given to eliminating as far as possible high frequency disturbances at the station, and this has apparently been effected by unique but simple arrangements. The lightning arresters are tapped off at the end of the incoming line, as usual, but the horn gaps and tanks are so placed as to furnish a straight path from the line to the tanks, enabling the latter to receive the dynamic blow of any oscillatory discharges, while the power line is turned through two right angles and through a choke coil before entering the substation. On the low tension side, instead of tapping the line through lightning arresters, the outgoing line is brought down to the arrester tanks and then returned to the station, forming a hairpin, with the open ends of same separated by an insulator. This arrangement again has a tendency to choke off any high frequency disturbances by virtue of the sharp break at the connections to the arresters, forcing surges to pass by the terminals of same. The system has been in operation since September 29th of last year, and the station has passed through several severe storms and other abnormal conditions, with interruptions for the seven months totaling not more than 90 minutes—a record, we believe, for placing in operation a system of this nature.

It is with no attempt to eulogize anyone that the entire system is pronounced a monument to good engineering—it speaks for itself. However, much credit is due Mr. Chas. O. Lenz, 71 Broadway, New York City, the chief engineer in charge of the work, and Mr. C. E. Bennett, who is associated with him and responsible for the entire layout of the electrical features of the system and the execution of same during construction.

Philadelphia Convention National Electric Light Association.

During the first week of June, the National Electric Light Association will hold its annual convention for the second time in the city of Philadelphia. In February, 1887, a little more than twenty-seven years ago, the fifth convention was held in the Quaker City with the records showing an attendance of about 500 members and guests, which, considering that the association was then two years old, would be a respectable showing, even in these days of convention enthusiasm and support. We have Secretary Martin as authority, however, that the Philadelphia meeting this year will set an attendance record for the city ten times larger than the previous one, namely, around 5,000. Evidently President J. B. McCall and Past-President W. C. L. Eglin intend that this shall be so and that a demonstration shall be made to prove their city worthy of the honor so long withheld, with Chicago favored seven times, New York five, and Boston twice in the meantime. This is a logical inference from the fact that early in February President McCall appointed a general committee to lay out and supervise the general arrangement of the June meeting, thus providing the first essential of a successful large gathering, namely, arrangement of details well in advance. The importance of the Philadelphia meeting is emphasized by reason of the fact that it also celebrates the thirtieth anniversary of the first International Electrical Congress held in America, and the first American International Electrical Exhibition, both being held in Philadelphia in 1884.

As usual the convention will formally open on Monday night, June 1st, with the reception to the president which will be held in the grand ballroom of the Bellevue-Stratford Hotel. Here also all of the regular sessions will be held in three well arranged meeting rooms. Real convention work will begin on Tuesday morning and will continue by means of parallel sessions during Tuesday, Wednesday and Thursday, ending with the usual important combined general and executive session on Friday morning. A well arranged and carefully laid out program has been prepared for these sessions, divided into general, executive, technical, commercial, accounting and hydro-electric sections in such a way as to enable those interested in one or more to take in the largest possible number of papers and discussions. This year an endeavor will be made to limit reading of papers and reports, and encourage discussion by permitting same to take up a larger portion of the time. The complete program will be found elsewhere in these columns.

The arrangement and facilities for conducting the convention this year are especially favorable to hard work, and provide a convenience to members and guests which will be appreciated and is seldom found in cities where the association has held its conventions heretofore. The entire convention will be held in one building, namely, the Bellevue-Stratford Hotel, with the convention meeting rooms as stated on the ballroom floor, one flight up and the exhibits of the manufacturing companies arranged in the roof garden of the hotel, where unusually ample space and variety of arrangement is available to show off apparatus.

While a rather low limit has been set for the allowable weight of any device that may be displayed, due to elevator and building limitations, it is not probable that this will prevent an arrangement and exhibition of as complete a display of electrical apparatus as has ever been shown at any previous convention.

Mr. J. B. McCall, President of N. E. L. A., and Also President of Philadelphia Electric Company.

The usual activity of the transportation committee is now in evidence, and reduced rates have been secured from the various passenger associations and special trains arranged to be run from Chicago, Pittsburg, San Francisco, Kansas City, St. Louis and Atlanta. On account of the excellent train service between New York and Philadelphia, and between Boston and New York, special trains will not be run from these points. The trains run from the cities named will accommodate those who attend from cities enroute and those who can conveniently make connections from adjacent points. Special arrangements are being made to secure a large Southern delegation from the Southeastern Section, the details of which arrangements are found elsewhere in this issue.

Southern Train to Philadelphia N. E. L. A. Convention.

Arrangements have been made with the Southern Railroad Company to run the special train—Magnolia Special—to the Philadelphia N. E. L. A. convention. This train will provide for every comfort of southern delegates and be the most complete that has ever been run from the south. It will be made up with Pullman drawing-room sleeping cars, club, observation and dining cars and start from the terminal station in Atlanta. Full details in regard to this train have been sent out from the New York office of the National Electric Light Association and the passenger department of the Southern Railroad Company has also arranged a complete itinerary giving details of connections and schedules for members in the various southern states who desire to take advantage of this opportunity to attend the convention in a body. As this issue goes to press a number of delegates sufficient to make the train a success and means of enjoying the trip have made reservations.

This train will leave Atlanta at 2:45 P. M. on Saturday, May 30, and arrive at Philadelphia Sunday the 31st at 3:30. Tickets will be sold for this train at all principal stations of roads in the southeast and general information in regard to the train can be secured at such points. Members living at points south and west of Atlanta in the states of Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, Arkansas and Tennessee, will find it most convenient and practical to use this train by way of Atlanta since this is the only means of securing the reduced round trip fare for the convention, the charge from Atlanta being $31.50. Those living in the states of North and South Carolina and Virginia will find it equally as convenient to make connections at the nearest junction point. If the southeastern section is to be represented at the Philadelphia meeting and show itself as strong as it really is, each and every member who plans to attend should not be content to make arrangements at the last minute, but inform Mr. A. H. Sikes, of Athens, Ga., member of the National Transportation Committee in charge, of your intentions so that he will be in a position to inform others as to the progress in filling up the available reservations. Any details of the arrangements can be secured from Mr. Sikes or from Mr. R. L. Baylor, division passenger agent of the Southern Railroad Company, Atlanta, Ga., who has the details of the schedules and connections in charge. Every southern central station manager who is a member of the Southeastern section is proud of it, he is jealous of the success public service companies have had during the past few years in this section—let us all show this spirit by going in a body to Philadelphia and taking with us as many members of our organizations as possible.

Program for the Different Sessions at Philadelphia Convention.

The following is the preliminary program for the general, technical, commercial, accounting, hydroelectric and public policy sessions of the Philadelphia Convention, June 1 to 6.

General Sessions.

First, Tuesday, 10 A. M. 1—Welcome to the City; 2—Address of President McCall; 3—Announcements; 4—Report of Committee on Organization of the Industry—Holton H. Scott; 5—Report of Secretary—T. C. Martin; 6—Report of Insurance Expert—W. H. Blood, Jr.; 7—Report of Committee on Progress—T. C. Martin; 8—Report on Question Box—S. A. Sewall; 9—Paper: Safety First—Paul Lupke.

Second, Executive Session, Wednesday, 8 P. M. 1—Action on Report of Public Policy Committee—Arthur Williams; 2—Presentation of Proposed Constitutional Amendments; 3—Report of Treasurer—W. F. Wells; 4—Election of Nominating Committee; 5—Appointment of Committee on Resolutions.

Third, Friday, 10 A. M. 1—Report of Committee on Award of Doherty Medal; 2—Symposium—Relation with Geographical Branch; 3—Report of Committee on Memorials—T. C. Martin; 4—Report of Committee on Constitutional Amendments; 5—Vote on Constitutional Amendments; 6—Report of Committee on Resolutions; 7—Report of Nominating Committee; 8—Election of Officers; 9—Adjournment.

Technical Sessions.

First, Tuesday, 2:30 P. M. Report of Committee on Meters—P. H. Bartlett; 2—Paper: A New Demand Indicator for Small Consumers—R. C. Lanphier; 3—Report of Committee on Grounding Secondaries—W. H. Blood, Jr.; 4—Report of Committee on Electric Measures—Dr. A. E. Kennelly; 5—Address: Electric Vehicle—C. P. Steinmetz.

Second, Wednesday, 10 A .M. 1—Report of Committee on Electrical Apparatus—L. L. Elden; 2—Paper: Temperature and its Relation to the Limiting Capacity of Electrical Apparatus—F. D. Newbury; 3—Report of Committee on Underground Construction—P. Torchio; 4—Report of Committee on Overhead Line Construction—Thomas Sproule; 5—

Third Technical and Hydro-Electric Session, Thursday, 2:30 P. M. 1—Report of Committee on Prime Movers, (a) Steam—I. E. Moultrop, (b) Hydraulic—J. E. Vaughn; 2—Selection of Hydraulic Turbines—Charles V. Sesastone; 3—Report of Committee on Street Lighting—J. W. Lieb, Jr.; 4—Report of Committee on Accident Prevention—M. J. Insull.

Hydro-Electric Sessions.

First, Thursday, 10 A. M. 1—Chairman's Address—W. W. Freeman; 2—Report of Committee on Hydro-Progress—T. C. Martin; 3—The Nature of Electrical Disturbances in Transmission Work—D. B. Rushmore; 4—Report of Committee on Distributing Lines—P. M. Downing; 5—Permanent Methods of Measuring Water in Water Power Plants—D. W. Mead; 6—Paper: Water Power Plant Economics—O. B. Caldwell.

Commercial Sessions.

First, Tuesday, 2:30 P. M. 1—Address of the Chairman of Section—T. I. Jones; 2—Report of Finance Committee—E. L. Callahan; 3—Report of Membership Committee—J. F. Becker; 4—Report of Publications Committee—Douglas Burnett; 5—Report of Committee on Education—F. C .Henderschott.

Second, Wednesday, 10 A. M. 1—Report of Committee on Rate Research—E. W. Lloyd; 2—Report of Lamp Committee—F. W. Smith.

Third, Thursday, 10 A. M. 1—Report of Committee on Non-Peak and High Load Factor Business—G. M. Jones; 2—Report of Committee on Interurban Lighting Highways—G. B .Tripp.

Fourth, Thursday, 2:30 P. M. 1—Report of Committee on Wiring of Existing Buildings—R. S. Hale; 2—Report of Committee Electrical Merchandising and Advertising—Parker H. Kemble; 3—Report of Nominating Committee; 4—Election of Officers.

Accounting Sessions.

First, Tuesday, 2:30 P. M. 1—Address of the Chairman of the Section—H. M. Edwards; 2—Report of Library Committee; 3—Report of Question Box Committee; 4—Paper: Cost and Statistics.

Second, Wednesday, 10 A. M. 1—Report of Committee on Uniform System of Accounts; 2—Address; 3—Paper: Variation in Public Service System of Accounting.

Third, Thursday, 10 A. M. 1—Paper: Accounting for Merchandise Sold—H. B. Lohmeyer; 2—Paper: Suspense Accounts; 3—Paper: Mechanical and Tabulating Systems (a) In Connection With Disbursement Accounts—F. A. Birch, (b) As Applied to Inventory of Transmission and Distribution Systems—G. L. Knight and C. V. Woolsey.

Public Policy Session.

Wednesday, 8:45 P. M. 1—Reading of Report of Public Policy Committee; 2—Address; 3—Music.

Status of Water Power Development in Georgia.

In a communication to the *Atlanta Constitution,* under recent date, State Geologist S. W. McCallie had the following to say on water power development in the state of Georgia:

The development of Georgia's water powers in the last decade has been phenomenal. Prior to 1903, or ten years ago, the only water power development within the limits of the state, which could be considered at all in the class with recent developments, was that of the Augusta Canal. For more than a quarter of a century this water power held the unique position of being the most extensive water power development in the Southern states. The early completion of this canal, which was a municipal undertaking of no mean proportions for its time, at once placed the city of Augusta in a position to offer attractive inducements to manufacturers in the form of cheap power—a financial consideration which has been the means of making Augusta one of our most important manufacturing centers and has won for that city the appropriate title, "The Lowell of the South."

The following tabulated data, collected by the writer since the first of January, during personal visits to the individual plants mentioned, gives the developed and ultimate development in horsepower of all of the main water plants at present in the state:

DEVELOPED WATER POWERS OF GEORGIA.

Stations.	Present Development. Horsepower.	Ultimate Development. Horsepower.
Georgia Railway & Power Co.:		
Tallulah Falls, Tallulah River	85,000	102,000
Mathis Storage Dam, Tallulah River		10,000
Bull Sluice, Chattahoochee River	17,500	17,500
Dunlap Shoals, Chattahoochee River	3,400	3,400
Total	105,900	132,900
Augusta Canal, Savannah River:		
Augusta Factory	1,079	1,079
Enterprise	1,085	1,085
Sibley	1,429	1,429
King	2,516	2,516
Sutherland	215	215
A. & A. Rwy. W. Plant	1,065	1,065
Clark Milling Co.	167	167
A. & A. Rwy. E. Plant	1,402	1,402
Murray Hill	164	164
City Pumps	850	850
Other Powers	1,486	1,486
	11,458	11,458
Georgia-Carolina Power Co.:		
Stevens Creek Development, Savannah River	3,125	31,25
Athens Ry. & Electric Co.:		
Station No. 1, Mitchell's Bridge	1,025	1,025
Station No. 2, Tallassee Shoals	1,300	1,300
Station No. 3, Barnett Shoals	5,600	5,600
Total	7,925	7,925
Gainesville Ry. & Power Co.:		
Chestatee River, near Dahlonega	1,500	1,500
Central Georgia Power Co.:		
Ocmulgee River, **40 miles above Macon**.	22,000	33,500
Columbus Power Co.:		
No. 1—North Highlands	8,770	8,770
No. 2—North Highlands	1,990	1,990
No. 3—City Mills	1,076	1,076
No. 5—Goat Rock	9,600	40,000
Total	21,436	51,836
Eagle and Phoenix Mills.		
Chattahoochee River at Columbus	5,900	5,900
Albany Power & Mfg. Co.:		
Muckafoonee Creek, near Albany	2,500	2,500
Grand Total	181,744	278,769

Other early developments which may here be referred to as furnishing rather large powers are those at Columbus; but these, like the Augusta canal power, are now so far overshadowed by the magnitude of some of our recent hydro-electrical developments that they have become of only minor importance.

The estimated horsepower above given, it should be noted, is in water-wheel capacity, the present development being in water-wheel capacity as now installed, and the ultimate development being the full water-wheel capacity of the plant when equipped according to the original designs. By comparing the total present water-wheel capacity with the total ultimate water-wheel capacity, it will be observed that the latter is more than one and one-half times that of the former. In other words, Georgia's water power plants are at present producing less than three-fifths the power for which they were constructed; or, to state it differently, these water power plants as now developed can be increased by the installation of additional units in the present plants more than one and one-half times.

The smaller developed water powers of the state have not been included in the above estimates on account of the great difficulty in securing reliable data. Had these powers been included, the above total present developed water powers would be increased by possibly as much as ten thousand horsepower. This would give the total present water-wheel capacity of all the plants now operated 191,744 horsepower. Comparing these figures with unpublished data recently compiled by Mr. B. M. Hall, formerly a member of the Hydrographic Division of the United States Geological Survey, who estimates the total wheel installation water powers of the state at 1,323,600 horsepower, we find that our present developed powers are only about 14 per cent of our total water power.

The Tallulah Falls Development of the Georgia Railway & Power Company

BY C. E. BENNETT, ELECTRICAL ENGINEER WITH C. O. LENTZ, CONSULTING ENGINEER, NEW YORK CITY.

Section 1. Details of Hydraulic Features, Power Plant Buildings, and the Electrical Equipment of Tallulah Falls Development.

THE hydroelectric development of the Georgia Railway & Power Company at Tallulah Falls, Ga., and the system for transmission and distribution of the electrical energy generated at this point, involving as they do, diversified engineering problems, can best be discussed under definite headings, and for this reason the following classification of the engineering work is made: 1. The Tallulah Falls plant, including hydraulic features, power plant buildings, and electrical equipment. 2. The transmission system and the Atlanta substation. 3. The sectionalizing, cross-over and transformer substations. In what follows the details of the first section will be taken up.

In the main, the hydraulic features of this plant include a storage reservoir, a diversion dam, an intake at the diversion dam connected to a forebay by a tunnel over one and one-quarter miles long, and five penstocks with Venturi meter arrangements connecting the forebay with the water wheels.

THE MATHIS OR STORAGE DAM.

The storage dam constructed in connection with the Tallulah Falls development is known as the Mathis dam, located six miles above the main or diversion dam, and creates a storage reservoir of 1,400,000,000 cubic feet. At Tallulah Falls a storage of 63,000,000 cubic feet is available for the water wheels on account of the main or diversion dam at times of smallest stream flow. Based upon the lowest stream flow recorded—that of 1904—the available delivered power due to both the diversion dam and the Mathis storage is 90 million Kw.-hrs. per year. For the years 1900 to 1913 the average recorded stream flow data show available delivered power to the extent of 125 million Kw.-hrs. per year, with the power plant at the Mathis dam raising this figure to about 140 million Kw.-hrs. These figures are for a 24 hour operating basis.

The Mathis dam is of the Ambursen type, with a reinforced concrete deck, concrete buttresses and reinforced concrete apron on the down-stream side over the spillway section. This dam is 90 feet high and 700 feet long, extending across the river bed. About one mile up stream from this structure another dyke dam of the same type of construction has been built across a depression about 50 feet below the elevation of the water line for this reservoir, which will be known as Lake Stevenson. These dams will raise the water in the reservoir to an elevation of 1,689 feet, making possible the storage of 1,400,000,000 cubic feet of water, as already stated.

The Mathis dam has 33 buttresses, spaced 18 feet center to center, with their footings approximately three feet below the original ground level. The horizontal joints of each buttress where intersections rest on thicker sections below are made up with raised jeys, so that there can be no possibility of horizontal sliding. The reinforced concrete deck, carried on the up-stream faces of the buttresses, of the arch beam type of construction, the face of the

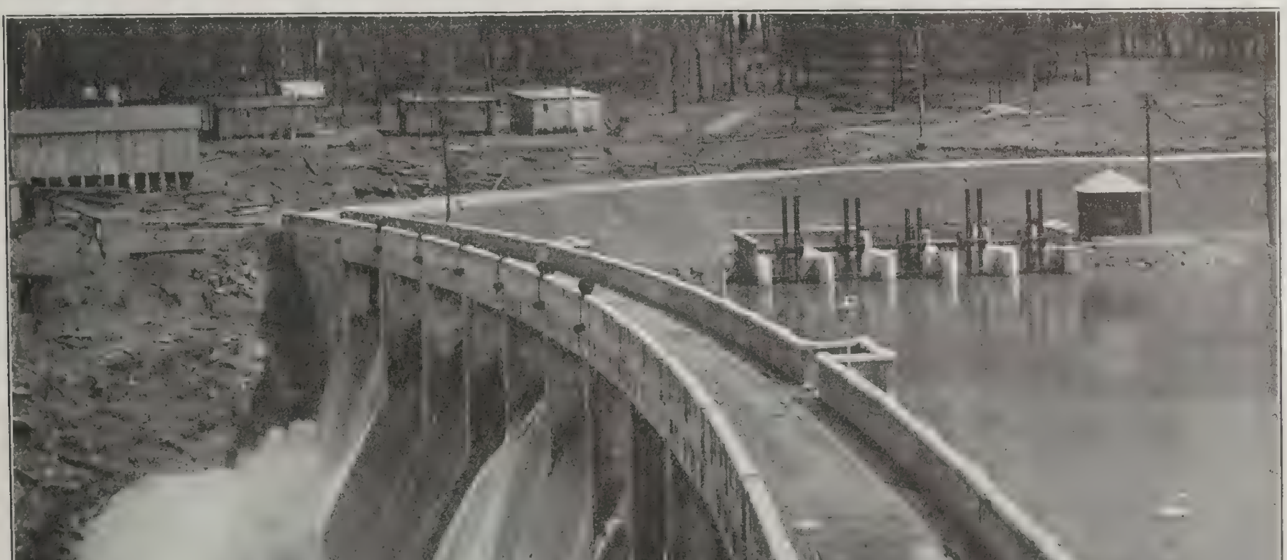


Fig. 1. Main or Diversion Dam and Intake to Tunnel of Tallulah Falls Development.

Note:—The photographs from which the illustrations used with this article were made, were taken by E. M. Nix, of the Georgia Railway and Power Company.

deck being flush with the up-stream faces of the buttresses. The thickness of the deck at the crown of the arch is 39 inches at the bottom and 18 inches at the top. The deck is sealed at the river bed by means of a cut-off wall 4 feet thick, which extends to 10 or 15 feet below the original ground surface.

The spillway deck and apron are constructed of reinforced concrete, and are designed to offer the least resistance to the passage of floods and at the same time protect the footings of the buttresses from undermining. The spillway apron is 18 inches thick. The crest of the dam is divided into 16 sections, each section being 16 feet clear between piers, which are 2 feet in thickness and carry a foot bridge about 12 feet above the crest of the dam. The concrete used in the structure was mixed in the proportions of 1 part cement, 2 parts sand and 4 parts crushed stone for the up-stream deck, crest and spillway apron, and 1, 3, 6 for the concrete and buttresses.

Three motor-operated 48-inch gate valves of special design are provided to drain the reservoir when necessary. These valves are provided with gates having a straight lower edge and thoroughly brass-fitted with machined-surfaced brass guides for the gate. This design was adopted on account of being most suitable for throttling purposes. Provision is made for the future construction of a power plant containing two 3,000 Kw. units to utilize the energy of the water drawn from storage and deliver this power over a transmission line to the main line at the power plant below.

MAIN OR DIVERSION DAM.

The intake dam is a rubble-concrete construction of the gravity type, arched to a radius of 900 feet. The maximum height of the dam is 110 feet above the original ground surface, with footings on solid rock from 10 feet to 20 feet below. The crest length is 444 feet, with a total spillway length of 280 feet, divided into 10 sections of 28 feet between piers.

The spillway is fitted with automatic swinging flash boards, hinged on the lower edge, and controlled by rolling counterweights, so arranged and designed that the elevation of the water back of the dam will be maintained within three inches of the normal elevation of 1,500 feet when passing a flood discharge of 12,000 second-feet. The counterweights are concrete cylinders 26 feet long by 3 feet 3 inches diameter, and are fitted at each end with heavily geared rolling contacts, which roll on specially curved racks attached to the side of the piers above the crest. As the flashboards are lowered, due to the pressure of the water, the counterwights are forced to roll up the incline by the pull of galvanized steel cables wound on a drum at either end of the counterweight and connected to the top of the flashboards.

The piers on the crest of the dam between which the flashboards are placed carry a highway bridge made up of plate girders imbedded in concrete, having a 12-foot roadway and platforms for hand-operated hoists for operating the flashboards, should this be desirable when the water is drawn down, or to enable the station operators to control the water at other elevation than that which the flashboards are designed to maintain. The footings of the dam were excavated below the river bed and at either end of the dam until solid and homogeneous rock was exposed. The earth and rock excavations necessary to secure suitable foundations amounted to 10,000 cubic yards.

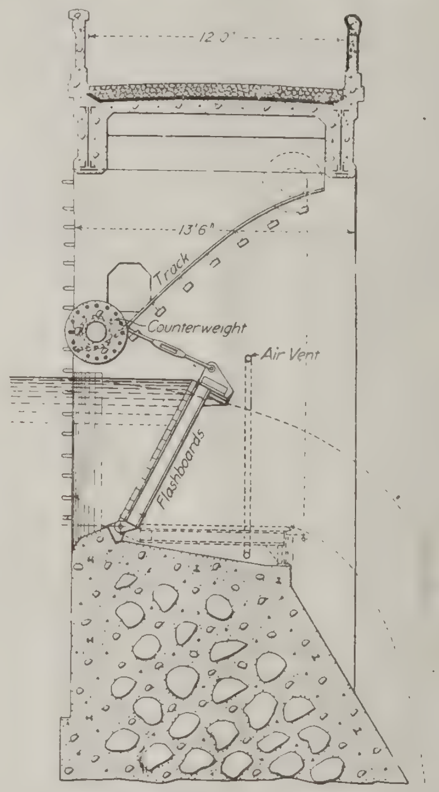


Fig. 3. Arrangements for Operation of Flashboards Showing Counterweights and Track.

The rubble masonry in the dam is made up of concrete mixed in the proportions of one part of Royal Portland cement, three parts of sand and six parts of crushed rock, in which rocks or "plumbs" which could be easily handled by derrecks were imbedded. The Royal Portland cement was manufactured by the Dixie Portland Cement Company, at Richard City, Tenn., each car being thoroughly inspected, and samples from each car were tested in accord-

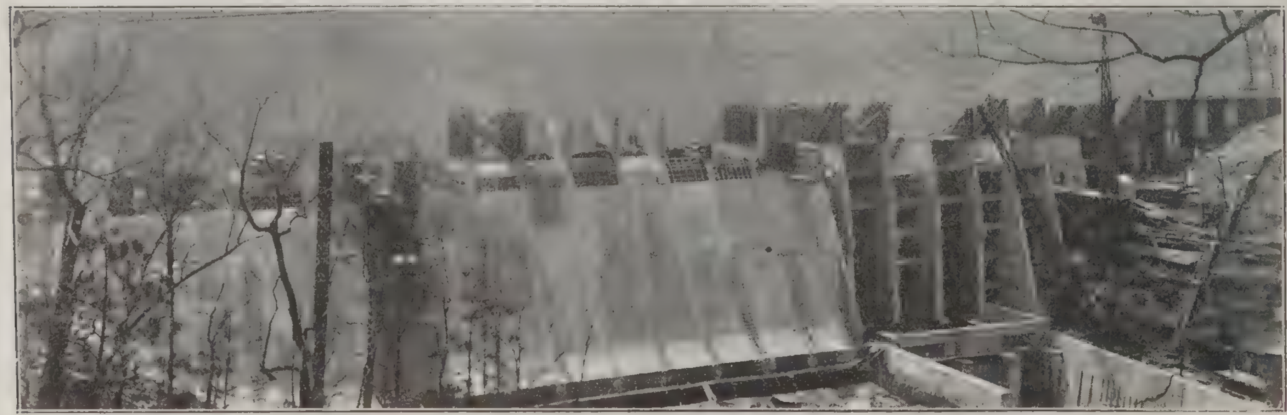


Fig. 2. Mathis Dam at Storage Reservoir Six Miles Above Main Dam.

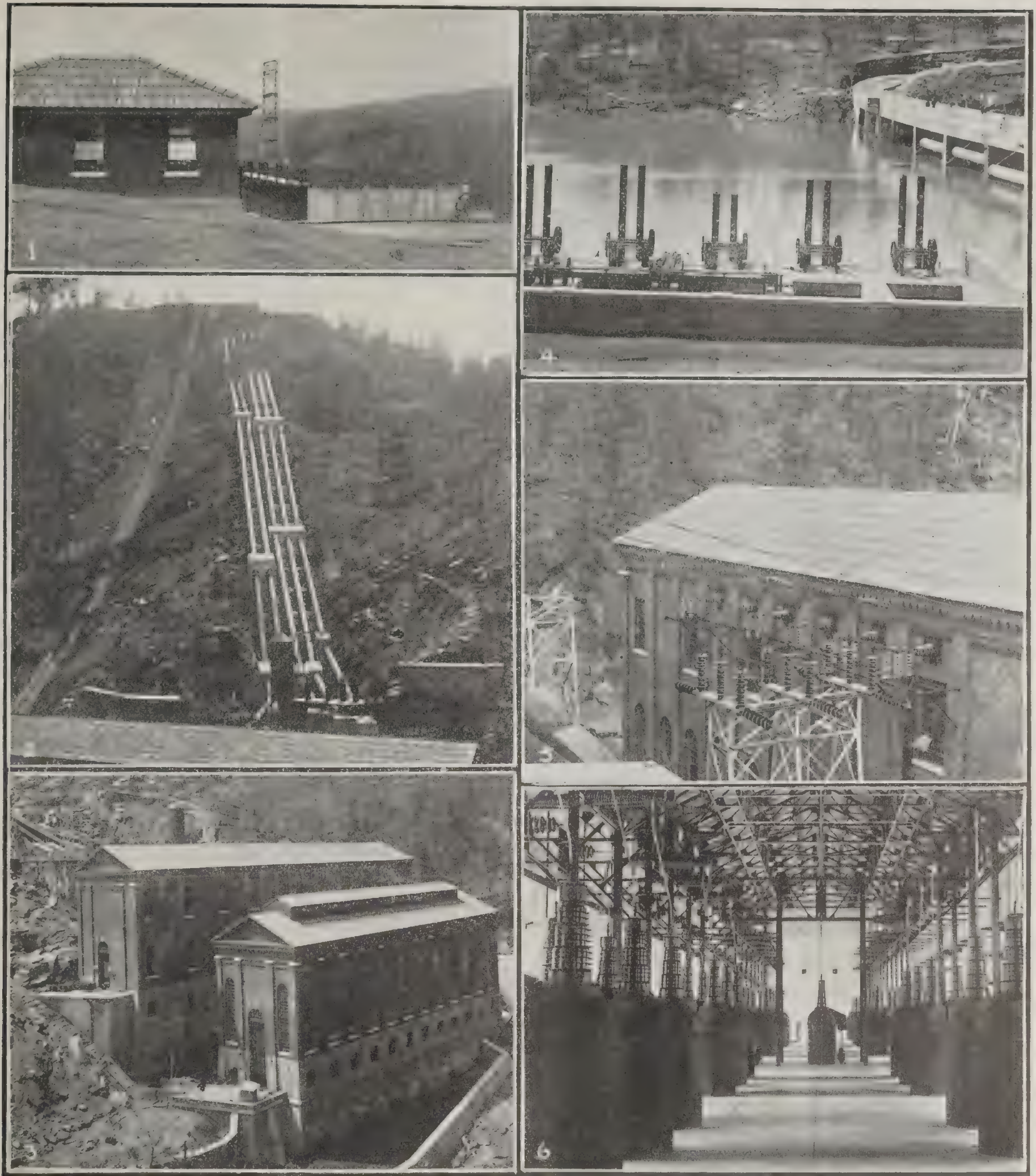


Fig. 4. (1) Forebay and Hoist House for Inclined Railway. (2) Penstocks from Forebay to Power House. (3) Switch House and Power House. (4) Main Dam Showing Counterweights for Flashboards and Gates for Intake to Tunnel. (5) Arrangements Where High Tension Lines Leave Switch House Showing Special Wall Bushings. (6) High Tension Room of Switch House Showing Wall Bushings, Oil Switches and Character of Wiring.

ance with the standard tests of the American Society for Testing Materials. The total amount of concrete in the dam is 38,000 cubic yards, and the work was placed at the rate of about 800 to 1,000 cubic yards per week.

INTAKE OF TUNNEL.

The intake forming the entrance to tunnel is a reinforced concrete structure, 62 feet wide by 38 feet from the front of intake piers to the face of the rear wall. The chamber, if divided into five sections by division walls three feet thick, each section being provided with an 8-foot by 10-foot structural steel gate, with hoisting apparatus and racks having a screening area of about 375 square feet per section, or 1,875 square feet for the entire intake. The division walls are 3 feet in thickness, and are extended for-

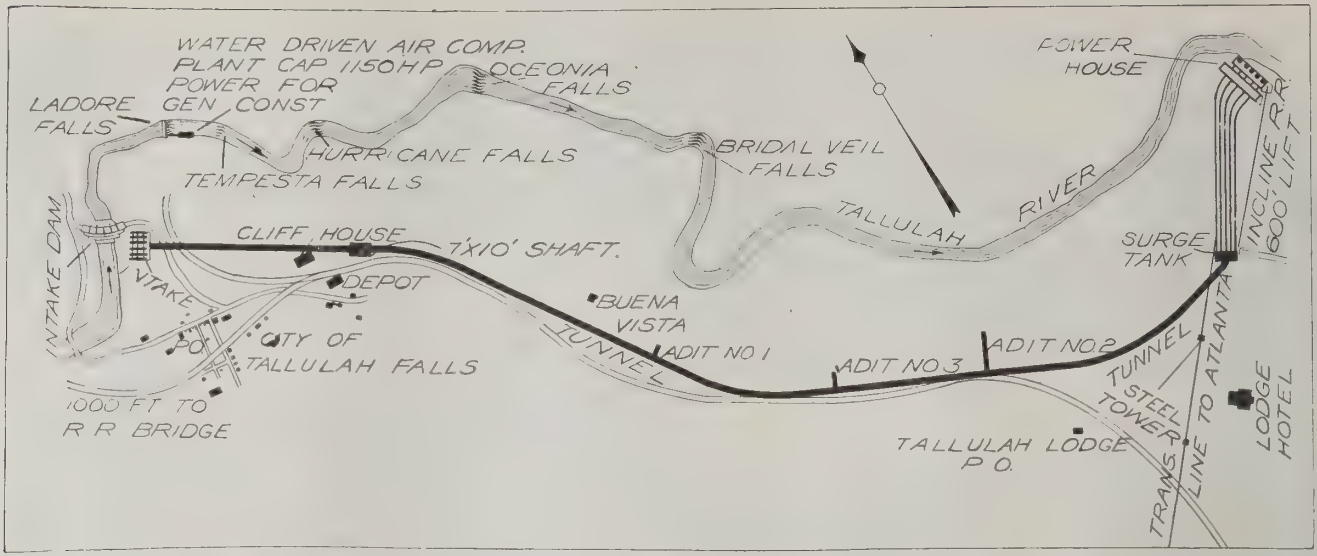


Fig. 5. Layout of Hydraulic Features of Tallulah Falls Development.

ward to form the intake piers. The piers are provided with stop-log grooves, and are arranged so that it is possible to gain access to any gate for repairs when necessary. At the rear of each division wall there is an opening 22 feet high by 11 feet 6 inches wide, which allows the water to pass to the tunnel entrance, located at the center of the rear wall at the bottom. The bottom of the tunnel is 26.5 feet below the elevation of low water and 46.5 feet below the elevation of high water in the reservoir, so that the top of the tunnel is always submerged at least 12 feet. The bottom of the intake slopes upward to the entrance gate, the bottom sill of the gate frame being 9 feet 6 inches above the bottom of the tunnel. The top of the intake is 21 feet 6 inches above the bottom of the tunnel.

An arched reinforced concrete thrust girder is placed at the center of the division walls to take care of the thrust from the side walls when the intake is unwatered. This girder is 5 feet wide and 4 feet deep at the crown of the arch, and is placed so that the top is about 3 feet above the low water elevation in the reservoir, thus forming a platform from which the lower set of racks can be raked by hand in the two sections which are not provided with mechanical raking devices.

The gate hoists are hand-operated. One of the hoists is fitted with steel gears, the other four with cast iron gears.

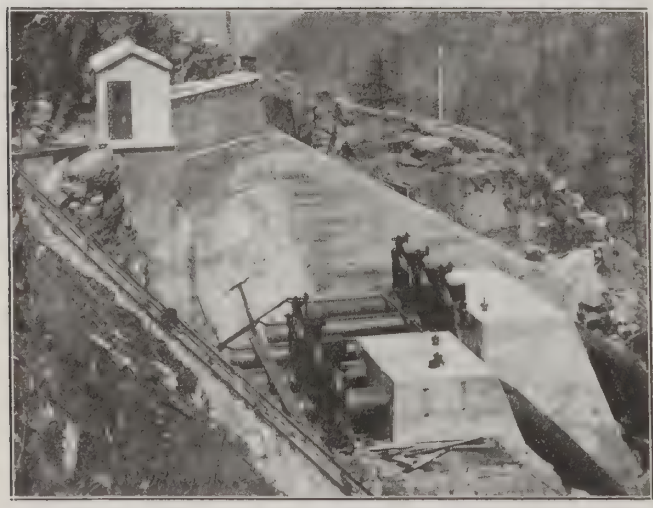


Fig. 6. Remote-Controlled Motor Operated Gate Valves for Penstocks.

The force is transmitted to the gate through structural steel gate stems, which pass through roller guide bearings.

The racks are made up of $\frac{3}{8}$ x 4-inch flat bars, spaced $1\frac{5}{8}$ inches center to center, and rest on 12-inch "I" beams. The slope of the rack is 5 inches to the foot from the vertical. Two sections of the intake are fitted with two sets of racks, each about 20 feet long. The other three sections are fitted with continuous racks and motor-operated mechanical raking devices to remove debris, particularly during the season of the year when leaves are floating in the water in quantities.

TUNNEL.

A concrete-lined tunnel, 6,670 feet long, connects the intake with a forebay excavated in the rock. The tunnel section resembles a horsehoe in shape, the height being 14 feet and the width 12 feet, with the top arched to a radius of 6 feet. The net sectional area is 151 square feet, and is lined with concrete for an average thickness of 18 inches. The tunnel has a maximum capacity of 1,555 cubic feet per second, with a velocity of water of 10.3 feet per second. The normal flow through the tunnel, with rated load on all the units in the plant, is 1,160 feet, and a corresponding velocity of 7.7 feet per second.

To facilitate the construction of the tunnel, one shaft and three adits were constructed. The distance from the entrance portal to the shaft is 1,283 feet; from the shaft to the first adit, 1,443 feet; first to second adit, 1,473 feet; second to third adit, 1,011 feet; and from the third adit to the discharge portal, 1,460 feet. Thus the workings of the tunnel have been conducted through five openings; the shaft is about 100 feet deep and about 10 x 12 feet in section; the adits are 7 feet high by 13 feet wide. The excavation of the tunnel was accomplished by first excavating a heading 8 feet high the entire length between adits and then excavating the bench. The rock encountered in places required special timbering, and was of such a nature that the progress of the work was greatly delayed.

The concrete lining was placed around steel forms by means of a specially designed air concreting machine. The concrete was mixed in the proportions of one part Portland cement, three parts sand made from rolled, crushed rock, and six parts crushed rock. The total amount of concrete for the tunnel is estimated to be 18,000 cubic yards, the total yardage of excavation being about 60,000 cubic yards.

FOREBAY.

The forebay at the lower end of the tunnel is designed to take care of the maximum surge due to the sudden closing of the gates of all the wheels when running at 25 per cent overload. It is estimated that during 25 per cent overload operation, the elevation of the water in the forebay will be about 12 feet below the elevation at the intake, due to friction losses in the tunnel, and that if all the turbine gates are suddenly closed, the resulting surge in the tunnel will raise the water in the forebay to about 29 feet above the elevation at the intake.

The bottom of this forebay is about 63 feet below the ground level, and is 30 x 71 feet inside in plan, and is 93 feet high. The walls of the forebay are of concrete, reinforced with heavy structural steel framework, with cross-tie beams. An emergency gate 7 feet 6 inches square, made of structural steel, is placed at the entrance of each penstock at the bottom of the forebay. Each gate is swung on pin hinges on the top side, and is held open by a chain passing over a hand-operated hoisting mechanism at top of the forebay.

PENSTOCKS.

From the forebay the water is conducted to the turbines through 60-inch penstocks. Five of these penstocks are now being constructed, with provision for a sixth to be constructed at a later date. The penstocks are of riveted and welded steel, varying in thickness from 3/8 to 9/16 inch, and are from 1,200 feet to 1,258 feet in total length from the forebay to the power plant. The greater portion of the penstocks are on grades exceeding 70 per cent, the maximum grade being 110 per cent.

At the upper end of the penstocks, remote-controlled, motor-operated gate valves 60 inches in diameter are provided. These valves are furnished with limit switches, and are to be operated from the power plant. At the lower end of the penstocks a heavy anchorage casting of cast steel is solidly imbedded in the mass concrete of the power

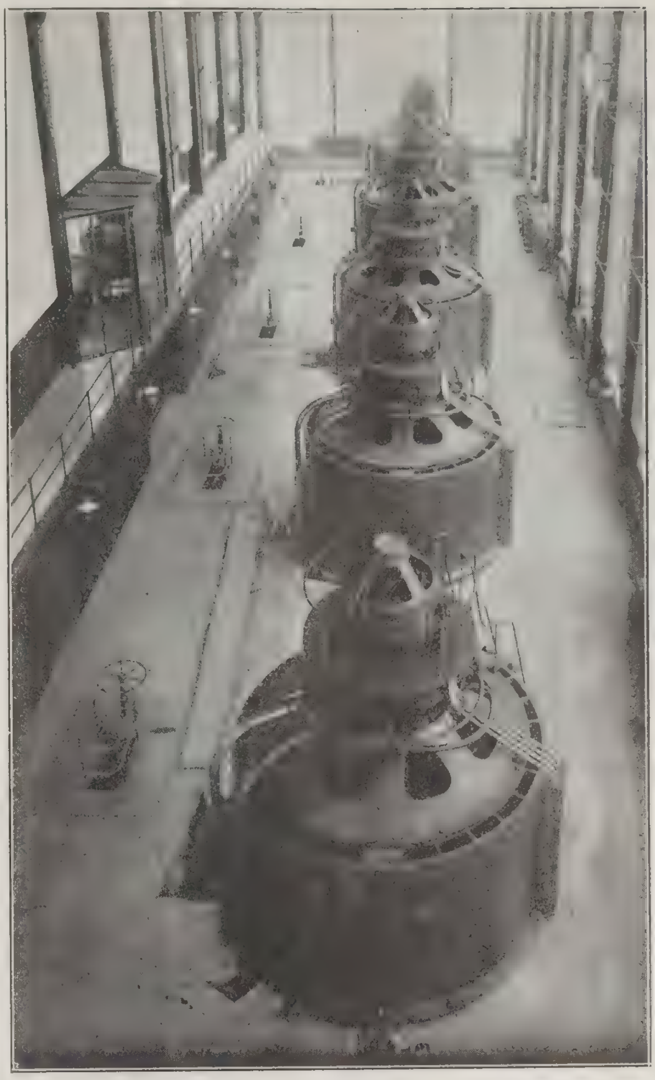


FIG. 8. GENERATOR FLOOR OF POWER HOUSE SHOWING SWITCH CONTROL STATION AT LEFT.

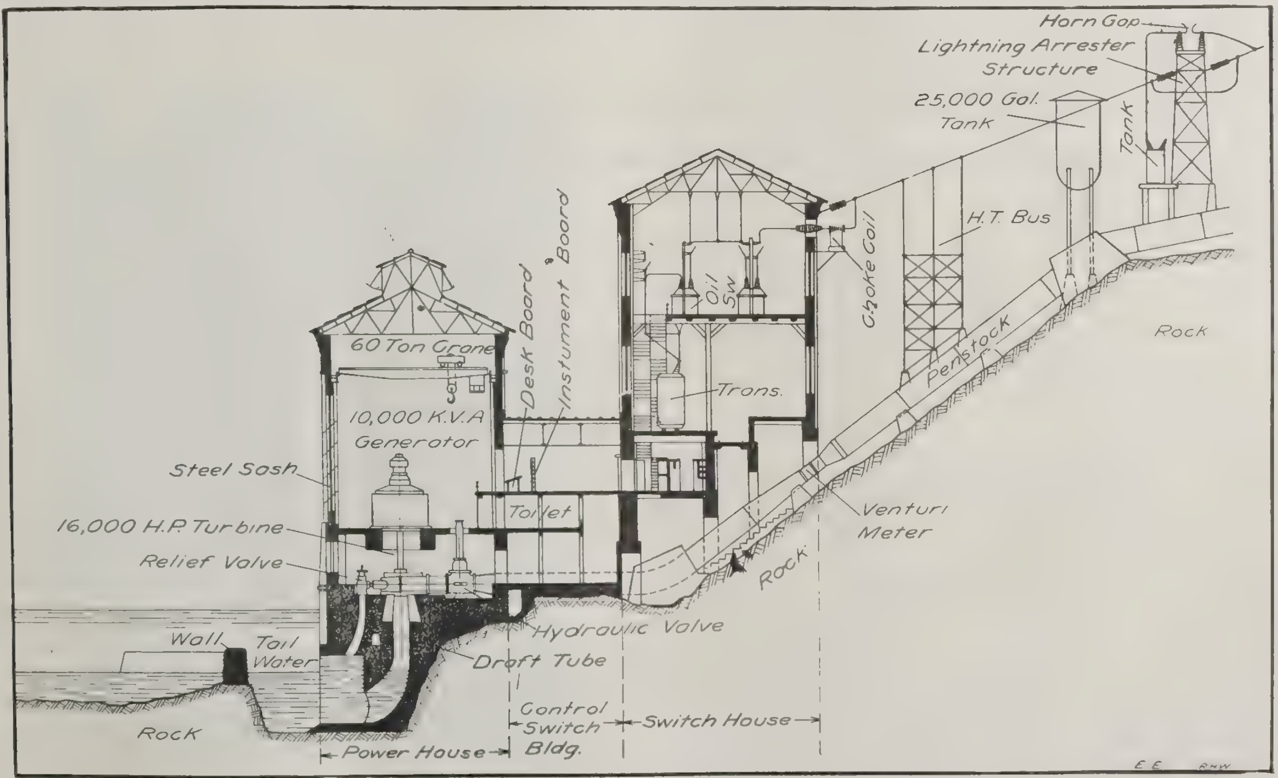


FIG. 7. SECTION SHOWING ARRANGEMENT OF APPARATUS IN POWER AND SWITCH HOUSES.

house, and connects with the turbine casing on one side and with a hydraulically operated gate valve on the other side. These anchorages are designed to take the thrust from the penstocks and thus relieve the wheel cases from stresses tending to impair their alignment.

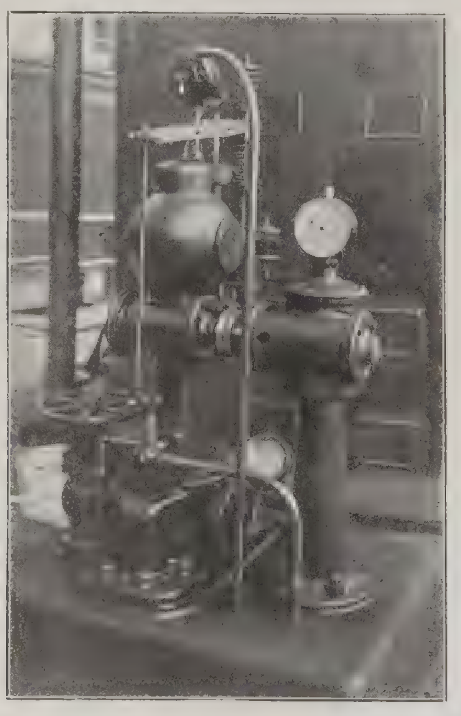


Fig. 9: Weber Type of Governor Used With Turbines in Tallulah Plant.

The hydraulically operated gate valves are 45 inches in diameter, and are fitted with leather-cup, ring-packed pistons. These valves are furnished with a pilot or operating valve, so designed that the gate can be held in any position as desired by the operator. The hydraulic pressure in the cylinder for operating the valve will be that due to the head of the water in the penstock. Above the hydraulic gate valve, and just outside the power plant, a Venturi meter is installed in each penstock. The meters have 35-inch throats. The indicating and recording instruments are located in the switch house. The Venturi meter equipment was furnished by the Builders' Iron Foundry, Providence, R. I.

The penstocks are carried on concrete piers, spaced about 32 feet center to center. At or near each change of grade a heavy concrete anchorage block is provided for each straight section over 100 feet in length.

POWER PLANT BUILDINGS.

The general arrangement of the buildings, which include the main power house, a transformer and a high tension switch house, resembles a letter "H." The power house faces the tail race excavated in the river bed; at the rear of the power house, and separated from it by a clear distance of 15 feet, the switch house is situated—these two buildings being interconnected by a small building containing the switch control apparatus. By this arrangement ample light is admitted on all sides of the principal buildings.

The main power house is 186 feet long by 42 feet 3 inches wide, and contains space for six main units, spaced 28 feet center to center. The lower chords of the roof trusses are 49 feet above the generator room floor. The foundations are of massive concrete construction, the foundation walls being of concrete to an elevation 1½ feet above the main generator floor. The generator room floor is constructed with heavy steel girder beams to distribute the loading from the generator frames, and the concrete is monolithic with the side walls. The generator room floor will have a sanitary finish.

The structural steel framework of the building rests on the concrete foundation walls. A plate girder runway is provided for a 60-ton crane. The roof trusses are of the Fink type, and support purlins having a 15-foot 6-inch span, on which the roofing tile are laid directly. The side walls of the power house are constructed of red brick, with marble pilaster caps and window sills. The roofing is of reinforced concrete tile construction, colored red to harmonide with the coloring of the side walls. The roofing tile are designed to rest directly on purlins spaced 4 feet center to center, and are arranged to seal weather-tight on all edges. A monitor extends nearly the entire length of

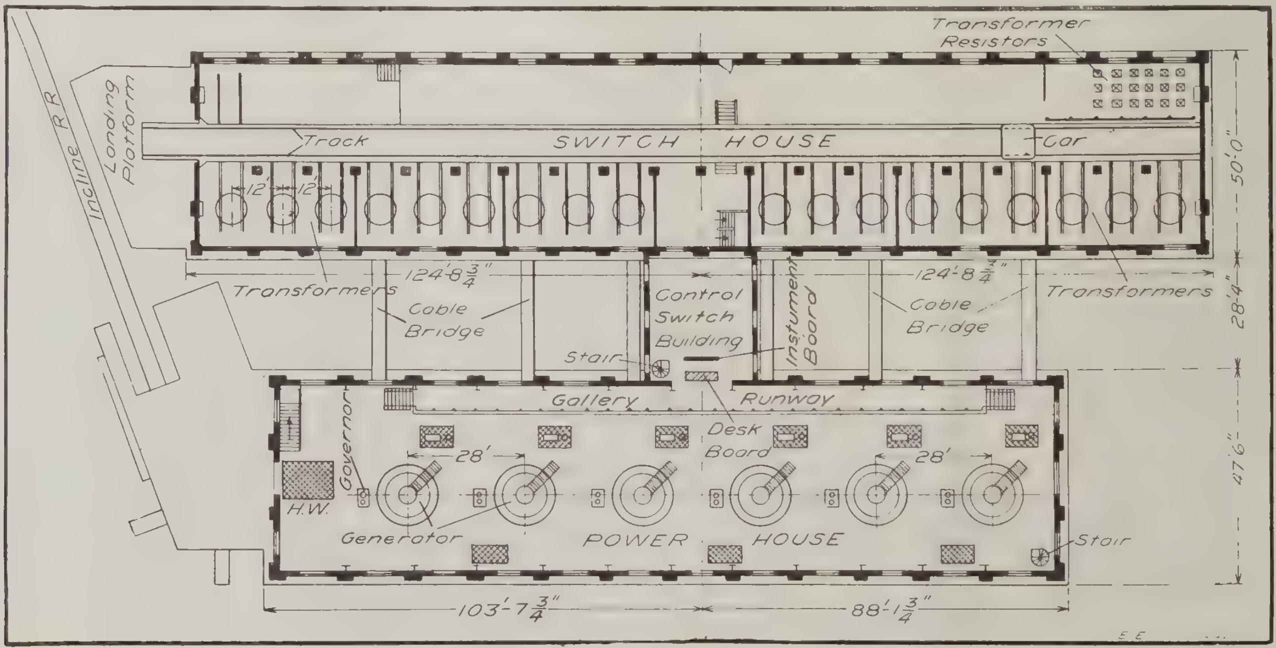


Fig. 10. Plan of Power and Switch House.

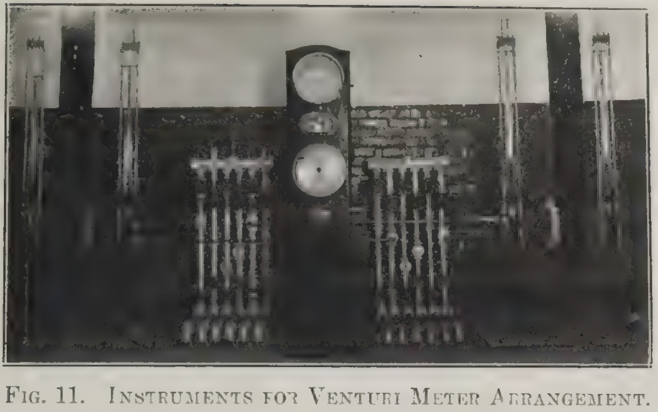


FIG. 11. INSTRUMENTS FOR VENTURI METER ARRANGEMENT.

the ridge of the roof, and contains about 1,200 square feet of window area.

The windows are of the "Fenestra" steel type sash, glazed with selected double-thick American sheet glass. The monitor sash and about half of the other sash are operated by the Drouve system of window operators. Rolling steel doors are provided at the principal entrances. Steel stairways and railings are provided at convenient places, extending from floor to floor.

A gallery 155 feet long, with a stairway at either end, is provided along the back of the generator room, which forms the roof of the rheostat rooms, and from which the operator commands a good view of the operating floor.

The basement of turbine room will contain the complete turbine unit, together with the pressure pumps and gate-controlling mechanism. The generator room floor above supports the frames of the main generators and the superimposed thrust bearings, which carry the entire revolving parts of the machines.

The transformer and high tension switch house is 244 feet long by 46 feet wide, and is situated on the side hill of the gorge back of the power house, so that the front wall is 15 feet from the rear of the back wall of the power house. The transformer room is above the low tension room, the elevation of the low tension switch room floor being the same as that of the gallery in the power house. This room provides space for eighteen transformers. The high tension switch room is located over the transformer room, and contains all the high tension switching gear of the station, as well as the high tension buses from which the electrical energy is taken out to the transmission lines.

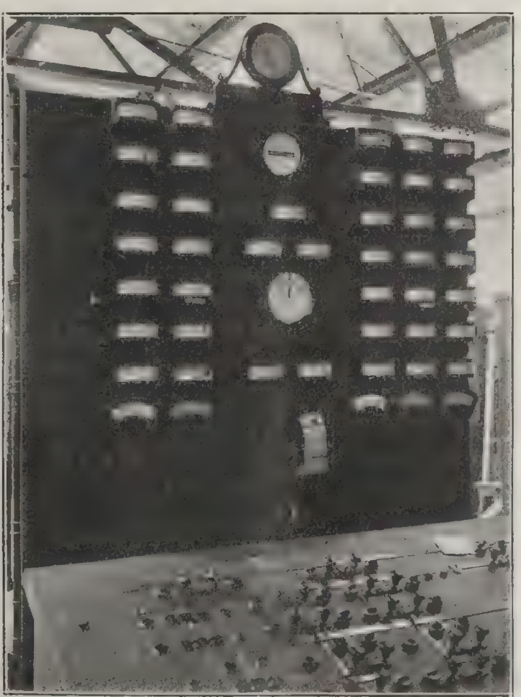


FIG. 12. METER SWITCHBOARD AND PORTION OF DESK BOARD AT TALLULAH PLANT.

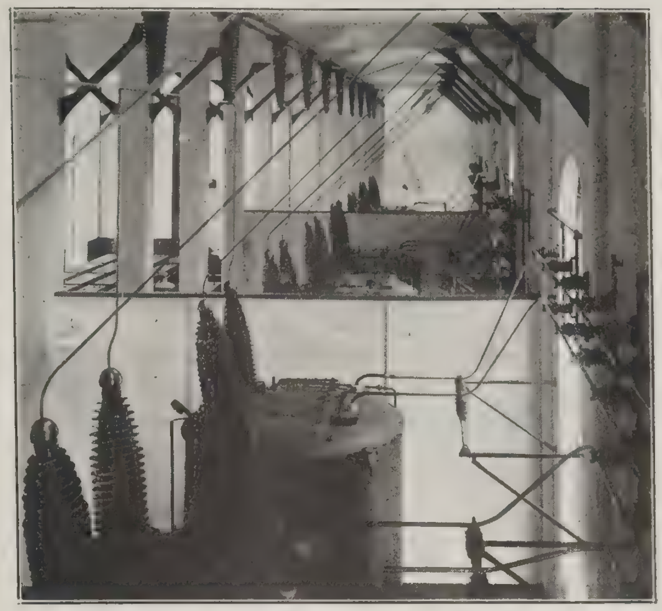


FIG. 13. TRANSFORMER ARRANGEMENTS IN SWITCH HOUSE

The general construction of the building is similar to that of the main power house, except that there is no monitor; and the roof trusses are of a special design, with a raised chord to provide the necessary buses without unnecessarily raising the walls of the building. A straight-flight steel stairway, with landings, connects all the floors. A traveling trolley hoist, electrically operated, has been installed for raising material to the upper floor. The transformers are located on either side of a track which forms the runaway for a transformer truck.

The small building connecting the two principal buildings is of the same general construction as the other buildings. The first floor, which is at the same elevation as the generator room of the power house, contains lavatory fixtures and lockers. The upper floor, which is at the same elevation as the gallery in the power house and the low tention switch room in the switch house, contains the switching gear for controlling all the main switches throughout the station.

HYDRAULIC MACHINERY.

The prime movers of the power plant consist of five 17,000 horsepower vertical shaft turbines of the Francis type, with scroll cases. Space is provided for a sixth unit, making the ultimate generating capacity 102,000 horsepower. The turbines are designed for an average head of 580 feet, and will operate at 514 revolutions per minute. Each turbine is provided with an oil pressure governor, twin-gate operating cylinders, and a heavy walking beam to operate the gates. A relief valve of special design to discharge about 70 per cent of the water in case of a sudden closing of the gate is connected to the scroll case of each turbine on the same center line as that of the penstock connections. The governor is of the Weber type furnished by S. Morgan Smith Company.

The runners are of special design and are of bronze.

The gates are of forged steel, with bronze-bushed pivot bearings and bronze-lined packing glands. The scroll cases are cast in one piece from selected cast iron and each case tested under 400 pounds hydraulic pressure per square inch. The scroll case casting is made in one casting, and is about 14 feet outside diameter and contains about 28 tons of metal.

The discharge of each turbine is through concrete draft tubes, lined with steel plate of such design that the water is delivered to the tail race with minimum disturbance of the water. The normal draft head on the runner is 22 feet.

The general arrangement of each prime mover consists of the turbine runner, the rotating field of the main generator, and the armature of the exciting generator, each superimposed above the other on the vertical shaft, and the whole carried by an oil-pressure thrust bearing at the upper end of the shaft. There will be two guide bearings—one above the turbine runner and one below the generator armature. The shaft is made in two sections of nickel steel, and with forged steel flanges and tapered flange bolts fitting into concentrically reamed holes. The governor pump and the pump for supplying oil to the thrust bearings are driven by worm-gear-driven countershafting in the generator room basement. Each unit is fully equipped with its own governor and thrust-bearing pumps, the thrust-bearing pumps being interconnected, so that the pumps can be operated interchangeably.

ELECTRICAL MACHINERY—GENERATORS AND SWITCHBOARDS.

The six main generators will be of the vertical type of 10,000 Kva. capacity, 514 r.p.m., 6,600 volts, 60-cycle, 3-phase, with 100 Kw., 250-volt exciters on the dome of the main generators. Each exciter is capable of exciting two generators at its full load. These machines will have a flywheel (WR^2) effect of 1,250,000 foot pounds. The revolving field is made up of solid-sheet steel discs, bolted together.

The switchboards will be placed on the top floor, overlooking the main operating room of the switch-control house, which joins the generator building to the switch house. There will be a deskboard, containing all the control switches, mimic buses, signal lamps, etc.; and directly in the rear will be vertical instrument panels, containing the indicating and integrating instruments. The exciter switchboard will be located on the main floor of the generating room, directly under the control panels. This board will control the six exciters and the auxiliary direct-current apparatus. Directly opposite each generator will be located a panel containing the field resistance dial, remote control field switch operators, signals, etc.

From the generators the main cables are carried to the adjoining switch house and connected through their respective oil switches, buses, etc., to the step-up transformers. Three single-phase transformers per generator group, of 3,333 Kva. capacity each, transform the voltage from 6,600 to 63,500 volts, giving 110,000 volts to the line potential when "Y" connected. From the high-voltage terminals of the transformers the energy is carried through high tension oil switches, buses, etc., to the outgoing lines. The neutral of these transformers are connected through a neutral resistance located at the end of the switch house.

The entire station control is centered about this point, and it is possible, by the use of remote control apparatus, to control the operation of all the main apparatus in the station. The generator rheostats are located under a gallery entirely isolated from the main operating room and ventilated with suitable louvers, so that the heat can be readily carried away.

In the main generating station the entire excitation is taken from the direct-connected exciters, there being no motor generators or water-driven exciters, thereby eliminating the use of complicated hydraulic connections in order to select any particular penstock.

The scheme of isolating each generator has been carried out, and the low tension transfer bus is the only connecting link between the generators in the low tension switching room. These oil switches are mounted in groups and separated by about 20 feet from each other. The high tension 110,000-volt bus is carried from the roof trusses of the high tension switching gallery, the trusses being of a special design in order to give sufficient clearance for the wiring. By this type of truss it is possible to considerably cut down the height of the building and use the usual waste space for wiring. The high tension wiring is carried from the switch house through a new type of line-entrance bushing specially developed for this plant, and will require no exterior protection from the weather other than the bushing itself. On the exterior of the building there will be an extension of the interior bus, making it possible to supplement the interior bus in case of trouble to bushings, insulators, etc. All the high tension electrolytic arresters, horn gaps, etc., are mounted on a structure located on the side of the hill adjoining the switch house.

The next section of this article will take up the transmission system.

The Effects of Ice on Stream Flow.

The design, installation and operation of any plant that depends for its success upon flowing water demands a knowledge of the total flow of the stream and its variation throughout the year. The United States Geological Survey has been compiling for years stream-flow records for many streams in the United States, and the methods for collecting such records for open-water periods have been standardized, but during the winter the presence of ice affects the flow so much that the laws of flow pertaining to open channels are not entirely applicable, and no standard methods for collecting and interpreting the data at that season have been recognized. In many localities ice persists in the streams for periods ranging from a few days to several months, and, although the conditions resulting from ice are most pronounced in northern regions, they are prevalent over wide areas, especially at high altitudes.

Recent studies made by the Geological Survey have added much information in regard to the factors influencing stream flow when ice is present, and with a view to standardizing, so far as practicable, the methods for ascertaining winter flow. Water-Supply Paper 337, entitled "The Effects of Ice on Stream Flow," by William Glenn Hoyt, has been published and is available for free distribution. This paper discusses the factors that influence the run-off during the periods of low temperature, the varieties of ice and their effect on the applicability of the laws of open-channel flow, and the collection and interpretation of necessary data.

Engineering Considerations in Connection with Passenger Elevator Systems

BY M. WILLIAM EHRLICH, CONSULTING ENGINEER, NEW YORK CITY.

Section 2. The Elevator Problem—Efficient Operation—Signal Systems—Number of Cars Required—Work of An Elevator.

THE design and construction of modern elevators is an art independent of the economic considerations due to the complexity of the problem, and the question the architect or his engineer is really interested in is the number and division of elevators that would most adequately fulfill the conditions of service now required in the highest type of office buildings. The fact cannot be denied that the growth and development of the "sky-scrapers," resulting in buildings of the types such as the Woolworth and many others, has been made a possibility only by the progress in the elevator industry. If the reliable, high-rise and high-speed elevator had not kept rapid pace with the years, surely few towering buildings would now adorn the skyline of lower New York.

The primary functions of an elevator—which in every sense is a public conveyance, carrying not only employes, but tenants and visitors—are not altogether unlike that of a railroad train. It is designed for the vertical transportation of passengers and thereby afford ready access to any floor of the building, while with regular train service the distances are, of course, horizontal, and all stations or landings are predetermined. Thus we see that in a commercial building the elevator is an absolute necessity, and by insuring easy ingress and egress of the tenants and the accommodation of the visiting traffic, it helps to maintain the monetary return on the building as a whole. The many passenger elevators now installed in apartment houses make allowance for buildings of any height, but it is an open question as to whether the economic value of the property is at all benefited by such action. In reality, the burden placed on these values by the installation of elevators as a convenience sometimes makes them an expensive luxury.

The question of greatest importance would naturally lie in the solution of an adequate service for the high-class commercial buildings. A modern commercial office building should be understood to signify that type of structure housing a tenancy of the usual classes occupying office space, and should not be mistaken for buildings devoted to any one kind of occupancy, such as railroad or insurance companies. This would immediately bring out the consideration of the division so common in high-grade commercial buildings—namely, the proper service of "local" and "express" elevators.

The primary object of any subdivision is, of course, to allow the tenancy on the upper floors the same opportunity of reaching the ground level as often and with an equal celerity as those persons occupying the lower floors, and this must be economically accomplished. The efficient operation of an elevator system does not rest altogether on the economic division and disposition of the cars, as the human element becomes one of the main factors. It is self-evident, therefore, that the service of an elevator is limited not only by the different classes of passengers entering, riding and leaving the conveyance, but by the experience of the hall man or starter and his ability to understand the demands of traffic and the peculiarities of the elevator operators.

It is now common practice to dispatch the various machines of an elevator system on a predetermined time schedule, thus avoiding to a great extent any confusion or overcrowding that would otherwise arise. It has been well established that the consecutive travel of elevators under schedule operation allows for a highly efficient service, not only in the handling of the traffic, but in the demand for power, which is thereby reduced to a minimum.

The power diagrams shown in Fig. 1 point to the effect of poor and proper service under different conditions. The upper curve (*a*) was taken under test conditions and represents the operation of one elevator. The load in the single car is approximately equal to the designed machine balance, both on the up and down trips, and the number of stops correspond to the average per car mile under actual service in office buildings. This diagram is given mainly to allow for a proper understanding of the combined curve (*b*), showing the actual round trip operation of a bank of elevators in one of the tallest New York buildings at the early morning hour. The full or solid line curve shows an excessive power demand due to an inconsistent "schedule," the cars having been dispatched by a starter, who may be identified by (X), while the dotted or broken line curve shows the more expert handling under the consecutive dispatching by starter (Y).

In order to avoid any unnecessary inconvenience to the tenants and the visiting traffic, and to maintain an efficient service at a minimum consumption of power, extensive signal systems have been resorted to in many instances. But, almost without exception, elevator systems in commercial buildings are provided with one of many varieties of signaling devices.

Though not the simplest, but without doubt the most efficient signal service now in use, is the automatic system of electric light indicators. Briefly described, the system is composed of a dynamotor supplying current for the

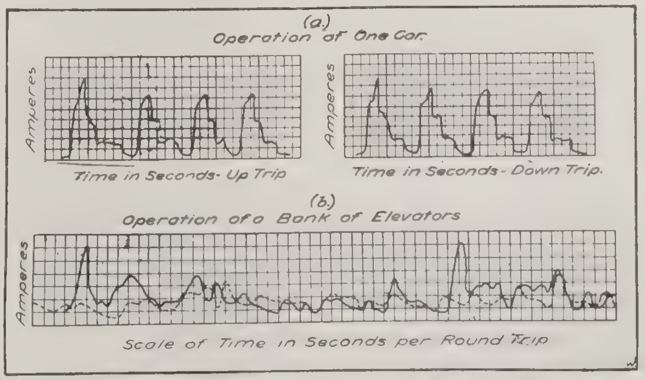


FIG. 1. CURRENT CONSUMPTION OF TRACTION ELEVATORS.

magnets, push-buttons and lamps. At each landing one or more sets of push-buttons are arranged for both the "up" and "down" signal, and over each elevator gate are two lamps, one over another, to indicate the direction of car travel, whereas each elevator is also provided with a signal lamp and a transfer switch or push-button. In addition to this, it is quite beneficial to install a mechanical indicator on the ground or main floor so that the starter may be well informed as to the location of the different elevators and thereby exercise full discretion as to when to dispatch the next car. The general signal system operates in a manner approximately as described below:

When a push-button is pressed for either direction at any floor, it actuates a magnet corresponding to that floor, which in turn signals to the operator in any approaching car, thereby indicating a waiting passenger, and, according to the movement of the elevator, further contact is made with the outside signal lamps at that floor showing to the waiting person the car approaching that floor and its direction. In a properly proportioned elevator system the transfer switch is seldom used, but in buildings where the travel becomes overtaxed during the rush hours, and an approaching car is filled to its capacity, the operator may press the transfer button and thereby signal the car following.

ECONOMICAL CONSIDERATIONS.

Having reviewed the development of elevators, leading through a discussion on the merits and disadvantages of the different types, and also the efficient operation of an elevator system, attention will now be given to the conditions affecting the number and division of elevators. Modern practice tends to show that the number of elevators required for any office building is really governed by the physical aspects and conditions of that building. Wherever it is not practical to use a car of large area, the number required will certainly be in excess of that necessary when large cars are used. It is not advisable, therefore, to base any conclusions on the number of cars to adequately fulfill a certain condition, unless the unite area of the car be considered.

The formula given below is well substantiated, giving economical service as based on existing systems in the larger cities of the United States, and by which the number of elevators required may be readily estimated. Note should be made of the fact that the unit area of the elevator car and its traffic limitations have been included in the computation, where

$$E = A \div 24{,}000 \qquad (1)$$

Where (E) is the number of elevators required for a building or any portion of same of a total gross area (A).

A simple manner of deciding the floor height at which the express car should make its first landing, or the floor from which a local service should then be started, is supported by many of the economic divisions of elevators now existing, and is as follows:

$$f = (0.5\,n + z) \qquad (2)$$

Where (f) is the floor at which the express run terminates and local service is continued, and (n) is the total number of floors passed and served, and for buildings not exceeding 30 stories, may be used as the full height of the structure, for above this height another "bank" or division may prove desirable.

The nominal running speeds of elevators customary in office buildings usually vary with the height of the structure, and are also governed by municipal regulations. In New York City, up to a short time ago, the speed was restricted to 400 feet per minute for locals, while express elevators were permitted a maximum of 600 feet per minute. On account of the many contemplated "tower" buildings, the regulations were changed to permit of a higher running speed. The figures given herewith represent the average load and speed combinations for various heights of buildings, together with the usual area of the elevator car as is consistent with the standard sizes manufactured:

TABLE 1—RUNNING SPEEDS OF ELEVATORS FOR DIFFERENT BUILDING HEIGHTS.

Bldg. Ht. (Floors)	Car Area (Sq. Feet)	Load (Pounds)	Speed (Ft. per Min.)
8 to 13	25	1700	250-350
14 to 22	30	2000	350-600
23 to 30	40	3000	400-600

It sometimes becomes necessary and is usually of interest to know the actual service derived from an elevator system. This may be accomplished by a test of actual conditions, or may be approximated by computation. Any formula that would lead to the desired results must take into consideration the time that a combined service occupies. It is most essential that the operation of an elevator system be known in detail, for a poor service may affect the commercial value or revenue of the building. Besides giving full knowledge of the status of the passenger traffic, the cost of operation may also be deduced.

The time an elevator occupies in starting at the main level and completing the entire run is called a trip. But as the car must always return to its starting point or main landing, the rise going up and the distance of travel down are considered as one and termed a round trip. The total time occupied is usually known as the round-trip time, and always expressed in minutes. The formulas as given below can only be used for an approximate estimate of the round-trip time, though the results obtained are well substantiated by many tests of actual operation. In the computations, (Te) is the round-trip time for express elevators and (Tl) is local time; (s) = the speed of the machine expressed in feet per minute, while (n) is the number of floors served. Then

$$Te = [(25/s) + (5/100)] \text{ and}$$
$$Tl = [(25/s) + (1/10)]. \qquad (3)$$

Having now decided on a means for calculating the time of total travel per hour, we may further, on a basis of average travel, deduce the miles traversed by the car, inclusive of over-travel, in that period of time. In the above and the other computations following, the sub-letter (e) is used to denote express, and (l) represents local operation. The mileage for a day's operation is, of course, the total hours of service times the distance of travel in one hour. The hourly mileage is found as follows:

$$Me = (n \times 2) \div (7 \times Te) \text{ and}$$
$$Ml = (n \times 2) \div (7 \times Tl) \qquad (4)$$

The (M) represents miles per hour, and the rest of the nomenclature is as explained before. Now that the travel is known, the cost of operation may be readily ascertained, if we know the cost of the electricity used. The approximate total current consumed per average hour of operation may be computed by the formula below, in which (C) is the kilowatt-hour consumption, or:

$$Ce = (n \times 115) \div (100 \times Te) \text{ and}$$
$$Cl = (n \times 115) \div (100 \times Tl) \qquad (5)$$

The many factors entering into the operation of passenger elevators would affect the current consumption to a considerable extent, and these varying items may be mentioned as the speed and load combinations, the number of stops and starts, including over-running, and the extent of the unbalanced load carried. Reference should be made to the diagrams in Fig. 1, heretofore explained. But the formula as given agrees with modern service under average operating conditions for electric traction systems, and where the drum type of elevator is used for slow-speed service the current consumption may be reduced by about 10 per cent.

The Selection, Care and Operation of Carbon Brushes

BY E. H. MARTINDALE, E. E., MEMBER A. I. E. E.

Section 1. A Discussion of Brush Friction.

In the average run of power plant and factory, very little study is given the subject of brush economy. In some cases the care and operation of brushes is in the hands of skilled and experienced engineers, with the selection controlled by a purchasing agent on the basis of price alone. In other cases the selection is based upon proper engineering requirements, but the care and operation are not properly handled. In either case maximum brush economy cannot be secured. Failure to recognize the essential details of this subject is often responsible for the conditions in both cases. When it is realized that a conservative estimate of the possible saving in most cases in the operation of a 100 Kw. generator may be placed at $240 per year, and a proportionate amount for any size of motor larger or smaller, the true proportions of brush economy are suggested. In what follows the writer will attempt a discussion of the proper selection, care and operation of carbon brushes, taking up the selection of same last, since this is based upon considerations of care and operation under certain conditions. In this section of the discussion brush friction will be taken up.

The coefficient of friction may be expressed as $\phi = F/P$. Where (F) is the frictional pull on the brush measured in a direction tangent to the commutator at the point of contact, and (P) the pressure of the brush on the commutator measured in a direction perpendicular to the commutator at the point of contact. The (P) pressure may easily be determined by a spring balance. The quantity (ϕ) has been determined in many laboratories and by the manufacturers of carbon brushes, so that with these values known, the frictional pull with various pressure and at various speeds may be obtained for any machine without much trouble. To illustrate a method in use, a view is shown in Fig. 1 of one corner of the brush laboratory of a brush manufacturing company. The machine in the foreground is the one used in the determination of brush friction. It consists of a copper slip-ring driven by a variable speed motor, which permits peripheral speeds from 1,000 feet per minute to 8,000 feet per minute. The rocker arm has four brush holders, each taking two brushes, 3 inches long, 2¼ inches wide and ¾ inch thick. The rocker arm is supported on a pin bearing, the friction of which is so small as to be negligible in comparison with the friction of the brushes. The rocker arm is prevented from rotation by a spring balance which gives the frictional pull.

Brush pressure in most cases is found to be variable, depending upon what the operator may think is best. Very often the pressure is whatever it happens to be, with no thought given to what it should be. Let us now consider the saving which may be effected by the proper use of the proper brush. We will assume that we are dealing with brushes on a 100 Kw., 220 volt generator. We might have assumed a 110 volt machine, which would have doubled the current and would require double the number of brushes, and therefore have doubled our saving. The coefficient of friction of brushes varies from nearly zero to above 0.9. For high friction let us assume 0.6 and for good friction 0.2. Let us assume 5 pounds per square inch of contact area as high and 2 pounds per square inch as good. About 30 amperes per square inch is a fair average value for carrying capacity used by designers until within the past two or three years, when the use of interpoles and high carrying capacity brushes have made possible the use of densities of 45 to 60 amperes per square inch. Let us assume for this illustration a current density of 30 amperes per square inch of brush area. A 100 Kw., 220 volt generator delivers approximately 450 amperes, so that at 30 amperes per square inch 15 square inches of positive and 15 square inches of negative brush surface would be required, or a total of 30 square inches. The peripheral speed of the commutator is the speed at which a point on the commutator is traveling through space, and is, therefore, the product of the circumference of the commutator and the revolutions per minute generally expressed in feet per minute. In modern practice this speed varies from very low values up to 5,400 feet per minute, and is getting higher every year. A few years ago 4,000 feet per minute was considered about the limit, but the manufacture of very low friction brushes has made possible the higher speeds.

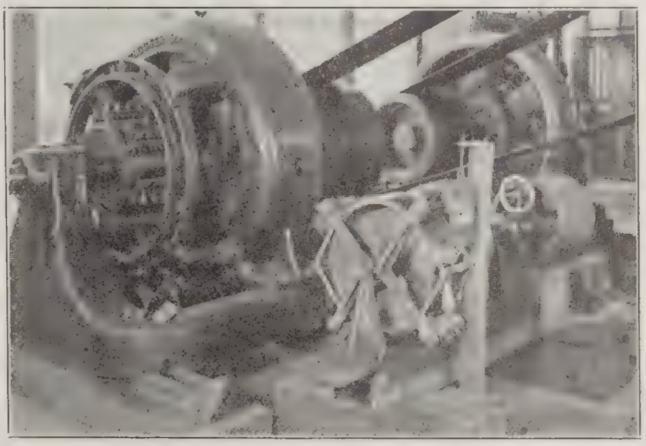


Fig. 1. Apparatus for Testing Brush Friction.

For this 100 Kw. generator let us assume a peripheral speed of 3,800 feet per minute, which is a fair average figure. From the following formula we can now show the loss caused by friction:

$$W = [A \times P \times \phi \times S] \div 44.26$$

Where W is loss in watts; A is area of brush contact in square inches taken as 30; P is brush pressure in pounds per square inch taken as 5; ϕ is coefficient of friction taken as 0.6; and S the peripheral speed of commutator in feet per minute taken as 3,800. Since one watt equals 44.26 foot pounds per minute, then

$$W = [30 \times 5 \times .6 \times 3{,}800] \div 44.26 = 7{,}727 \text{ watts.}$$

Or the loss is more than 7.7 Kw. Taking 1.5 cents per Kw.-hr. as a fair value for power, this loss is, then, equal to 11.55 cents per hour, or in an 8-hour day equal to 92.4 cents, which, in a year of 300 working days, amounts to a loss of $277.20.

Now, considering good brushes and proper pressure as follows for use in the same formula—namely, A = 30; P = 2; ϕ 0.2; and A = 3,800—then

$$W = [30 \times 2 \times .2 \times 3{,}800] \div 44.26 = 1{,}030 \text{ watts.}$$

Here the loss is only 1.03 Kw. Then 1.03 × $0.015 × 8 × 300 = $37.08 loss per year. For comparison, then, we have:

Brush friction loss under poor conditions.........	$277.20
Brush friction loss under good conditions.........	37.08
Unnecessary loss per year	$240.12

It is from this, a helf-evident fact that the first cost of a good grade of brush is a very good and safe investment.

Let us now consider a few of the other bad effects of too high brush pressure, besides the loss of power shown above. The capacity of any generator or motor is limited by the permissible temperature rise, and the unnecessary friction increases the temperature of the machine and therefore reduces its capacity. Too high pressure tends to cause the brushes to chatter, which increases the temperature of the commutator, just as pounding a piece of metal rapidly will make it hot. In addition to this heating, the chattering causes the brushes to momentarily jump from the commutator, and as this draws an arc between the brush and commutator, the brush becomes burned and pitted, the commutator black and burned, and the mica soon becomes high. If the brushes are abrasive, too high pressure will result in unnecessary wear of the commutator, and as commutators are expensive, this wear often becomes a high item in the maintenance cost of a generator or motor.

It is desirable here to distinguish abrasiveness from hardness. By abrasiveness we mean the scouring or cutting qualities of a brush which does not in any way depend upon its hardness, and may be determined by cutting the brush with a knife or by marking with it on paper. Some of the hardest brushes made have no abrasive material in them and will not wear even a slotted commutator perceptibly in several years. Likewise some of the softest graphite brushes are abrasive and will wear a commutator rapidly. Too high brush pressure will thus result in too rapid wear of the brushes and sometimes reduce their life to one-third or one-fourth of that possible.

On the other hand, too low pressure is as detrimental as too high pressure. Low pressure will cause poor contact between the brushes and the commutator, and force the current to pass from one to the other through a small arc. This will burn both the brushes and commutator and produce high mica. The heat of the arcs between brushes and commutator will also increase the temperature rise. Further, poor pressure produces a high contact drop, which will also heat the commutator and brushes. This high contact drop and arcing caused by too low pressure frequently heats the brushes to a red heat, or, as we say, "to the glowing point," which is always accompanied by pitting or disintegration of the faces of the brushes. This again reduces the available contact area and increases the current density through the balance of the brush. The bad effects of too low brush pressure are greatly aggravated when the commutator is slightly elliptical or runs unbalanced.

Whether the pressure is high or low, great care should be, but seldom is, exercised to get all the brushes on one machine at a uniform pressure. The writer has frequently found machines where the pressure on any brush would not be, normally considered, too high or too low, yet, due to an unequal pressure, the machine operated very poorly. If the pressure is unequal, the brushes with the highest pressure will carry the highest current. In many cases the writer has found some brushes on a machine carrying three or four times as much current as other brushes, due to this variation in pressure. This excessive current may be enough to burn off the pigtails, overheat the brushes, and cause glowing and pitting of the brush faces. The best value of brush pressure should be determined for any machine by trial, as it is influenced greatly by local conditions. The writer ordinarily recommends a pressure of from 1.75 to 3 pounds per square inch of contact surface for generators, and from 4 to 7 pounds per square inch for such machines as crane motors and railway motors where vibration is comparatively severe. However, these values are given only as an indication of best average practice, and are not always the best to use.

An excellent method for increasing the efficiency of machines when in doubt of brush operation is to give a brush manufacturer as much detail as possible regarding the machines and their operating conditions, and permit their engineers to determine the grade of brush and the best pressure. Such recommendations will be based upon experience obtained from thousands of different machines operating under different conditions, and, while their recommendations are not infallible, they will nearly always hit the mark.

Some of the causes of sparking at the brushes will be taken up in the next section of this article.

Meeting of Society for Electrical Development at Philadelphia.

The Society for Electrical Development announces that their annual meeting will be held at the Bellevue-Stratford Hotel, Philadelphia, on Monday, June 1st, at 10 a. m. The object of calling this meeting at this time is to enable those who are attending the N. E. L. A. convention at Philadelphia to also attend the annual meeting of the society. At this meeting new directors will be elected, and immediately following there will be held the annual meeting of the Board of Directors, at which the officers for the coming year will be elected.

Porcelain High Tension Line Insulators

BY R. L. SHEARER, TRANSPORTATION EQUIPMENT INSPECTION BUREAU, NEW YORK CITY.

Some Practical Details of Design and Operation of Insulators.

THE manufacture of porcelain is one of the oldest known arts, yet it is only during recent years that it has been used to any great extent for electrical purposes. Porcelain is particularly suitable for high voltage insulation, as it has high insulating value; is homogeneous, giving uniform distribution to electrical strains; is practically waterproof; has high mechanical strength; can be moulded into various shapes; does not deteriorate, and it will stand sudden and extreme changes in temperature. Electrical porcelain, chemically considered, is a double silicate of sodium or potassium and aluminum. It is composed of flint, feldspar, kaolin or china clay and ball clay. These are fused into a homogeneous mass at extremely high temperatures, with a material (porcelain) as the result which, so far as known, remains unacted upon by natural forces for an indefinite period.

The design of the high tension insulator depends on the mechanical and electrical characteristics of transmission lines when subject to the worst conditions to which they may be put in practice. It is usual practice to test all designs to their ultimate strength by immersing in oil and puncturing to ascertain the flashover value when subject to a heavy rain, and to test mechanically to destruction by applying force in a manner in which the insulator will be obliged to carry a load when in actual line service. Rain tests on pin type insulators have usually proven most unreliable, due to angularity of the spray, its fineness, rate of precipitation, velocity, temperatures, distance of nozzles from insulator, time element, etc.

Suspension insulators need to be manufactured with great care to attain uniform electrical and mechanical characteristics. Of prime importance is the electrical strength of the units, inasmuch as that unit adjacent to the line wire may at times be subject to its full flashover potential. It is important, therefore, that such units be capable of resisting potentials up to flashover with a good margin of safety. Suspension strain insulators may be used in any position, and no fear need be entertained of failure due to the wetting of all surfaces, as provisions are made for sufficient leakage distance to prevent appreciable leakage, even when subject to the worst possible conditions.

The pin type line insulators are usually built up of two or more parts. In large pin type insulators, designing of the parts so that they will have a high flashing potential compared with the stress which they have to carry at flashover on complete insulator, permits of a test factor of safety. In the suspension insulator the section length is reduced so that the entire insulator flashes before the tested or flashing potential for a part is reached. Through its inherent design, the suspension type of insulator is better able to withstand puncture than the pin insulator, yet when making a selection careful attention should be given to this phase of the design. The practical limit of the pin type insulator as at present developed is approximately 60,000 volts, because above this voltage the excessive pin length weakens the leverage, the necessarily small separation of pin and conductor solicits puncture, and the dimensions, weight and cost becomes excessive. The main advantages of the suspension type of insulators are adaptability, portability, simplicity of construction, somewhat better protection from lighting, and mechanical advantage due to reduction of tower strain.

It would appear that towers using suspension type insulators would necessarily have to be taller and more expensive than those using the pin type insulator. This is not the case, however, as the extra height required by having the crossarms above the conductors is compensated for by having the ground wire lower relative to the crossarm, but in the same relative position to the conductor. Of course, there is considerable difference in the crossarm stresses, but this is not sufficient to cause any appreciable difference in the cost of the tower. Insulators, when used on steel towers with grounded metal pins, are subject to much more severe voltage strains than when used on wooden poles with wooden crossarms, and it is necessary that greater care be taken in their selection and that a greater factor of safety be allowed. At high frequencies and with suddenly applied potential, such as would come from a condenser or lighting discharge, puncture is much more likely to occur, and due consideration has not, as a rule, been given to this fact. For this reason one should observe proposed designs from this standpoint, and, if possible, should make high frequency tests, or at least puncture tests under oil.

An insulator which has a surface arcing characteristic can never have a tested factor of safety greater than one at flashover. An insulator has a tested factor of safety when the air path from conductor to pin or support is broken down before a flashing point is reached on any section. By adding another unit the tested factor of safety would be increased. This latter will be true as long as the path over the surface shunting the air path will maintain a drop in potential equal to that necessary to rupture the air path. The amount of depreciation which an insulator will stand and not lower its rating depends upon the excess in surface insulation between the points where the arc forms. The surface not only prevents a serious loss of current, but is responsible for the potential gradient over the surface of the insulator, which is of no little importance.

The resistance of an insulator must be determined by taking the width into account as well as the length of leakage path. Surface resistance will vary directly as to length and inversely as to width. The petticoats increase the resistance of the lower surface 100 per cent. In this manner a high surface resistance can be obtained with small diameter.

In service the insulator must withstand two classes of stress—that of the line at normal frequency and voltage, and that of the high frequency surge. The insulator must operate indefinitely under the normal line potential, which affects every insulator on the system. The surge, however, may throw a very high stress on a few of the insulators, but only for an extremely short time. For reliable operation, no insulator should puncture or fail by flashing or spilling. To produce 100 per cent reliability against flashing or puncture would require a very large investment in the line, but it is possible to obtain a high degree of reliability at moderate cost by using the suspension insulator. In order to increase the reliability against puncture, it is common practice to test insulators at a potential several times that of the line; this weeds out a number of weaker insulators, but owing to the time element in breaking-down, does not insure reliability nor uniform strength.

Mechanical strength of insulators with metal parts cemented to porcelain. There has apparently been no great difficulty in securing desired strength when porcelain is cemented to porcelain, but there is some doubt existing as to the exact mechanical value obtained in the cementing of porcelain to metal, as there have been some reported failures of large pin type insulators where a large pin has been cemented into the insulator. Consideration of the relative coefficient of temperature and elasticity for porcelain and iron seem to indicate that the two could be used together successfully for the range in temperature and mechanical stress to which the insulator would be subject. Porcelain has a tensile strength of approximately 2,500 pounds per square inch. Good cement has a shearing ultimate of over 1,600 pounds per square inch. By making the gripping surface of the pin and pin hole efficient, the full shearing strength of the cement is developed and a high mechanical ultimate is obtained. Insulators may be designed so that the pin will pull without breaking the porcelain for the same ultimate by changing the diameter of pin and gripping surface so that the shearing strength of the cement is reached before a breaking stress is developed in the porcelain.

These points, as outlined, show the difficulties to be guarded against, and indicate the tests which can be made to advantage to check design and manufacture and insure a good, reliable insulator.

Characteristics of A. C. Circuits

BY A. H. TIMMERMAN.

Section 3. The Effect of Capacity and Reactance in A. C. Circuits.

ONE feature of the alternating current circuit on which we have not touched is that of a condenser, or capacity in the circuit. This is assuming more importance from the standpoint of the central station manager, due to the fact that by its introduction into the circuit, the lag of the current on the impressed electromotive force can be decreased. The effect of capacity in the circuit is indicated in Fig. 14, which shows a current which reaches its maximum value before the maximum value of the electromotive force is reached, and for comparison with previous curves we are showing this current leading the electromotive force by an angle of 45 degrees. Currents which lead the electromotive force by as large an angle as this are seldom found in practice, except in the charging currents of long transmission lines, the capacity of which is large.

The effect of capacity in the circuit is in every way similar, but opposed to the effect of reactance. In other words, while reactance produces a lag, capacity produces a lead in the current. It is, therefore, not difficult for us to see the effect of the introduction of resistance, reactance and capacity in the same circuit. By properly adjusting the capacity and the reactance we can produce currents which are exactly in phase with the electromotive force, or leading or lagging behind it by any angle, less than 90 degrees, desired. In a circuit containing nothing but capacity, the current leads the electromotive force by exactly 90 degrees.

The leading current due to capacity in the circuit is shown nicely in Fig. 14, which represents a circuit containing resistance and capacity so divided that the voltage used to overcome the resistance is just equal to that required across the terminals of the condenser. The current now leads the electromotive force by 45 degrees, that is, both the zero and maximum values of the current occur 45 degrees before the corresponding values of the electromotive force.

The power curve W is similar in every way to that shown in Fig. 13 for a circuit containing resistance and reactance, except that it has been displaced to the left a distance of 45 plus 45 or 90 degrees. The meaning of that portion of the curve below the horizontal axis, or the negative power given by the generator represents the discharge of the energy stored up in the condenser. This energy is stored up in the form of an electrostatic field instead of electromagnetic field, as in the case of the reactance, and it should be noted that the power delivered by the generator is of a fluctuating character. This curve represents conditions in an unloaded long transmission circuit, in which the charging current is largely due to the capacity of the lines. As the load comes on the current curve shifts to the right, until it is finally in phase with the electromotive force. As such lines are usually loaded with a partially inductive load, this shifting of the phase will continue as more load is applied, until the current lags behind the

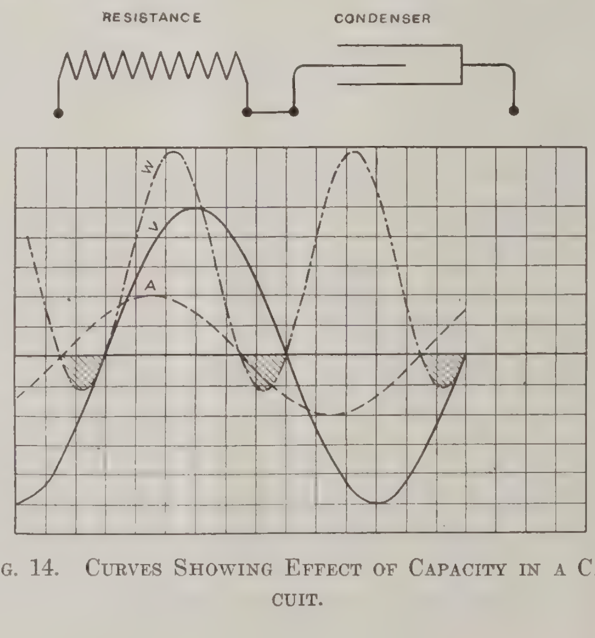


Fig. 14. Curves Showing Effect of Capacity in a Circuit.

electromotive force. It frequently happens that the charging current of the line is so great that as an inductive load is applied, the ammeter actually shows a decrease in current, due to the fact that the current and electromotive force come more nearly into phase. If the transmission line had no resistance, the charging current could lead the electromotive force by 90 degrees. The resistance of the line, however, will modify this to some extent giving a value of the angle of lead somewhere between zero and 90 degrees.

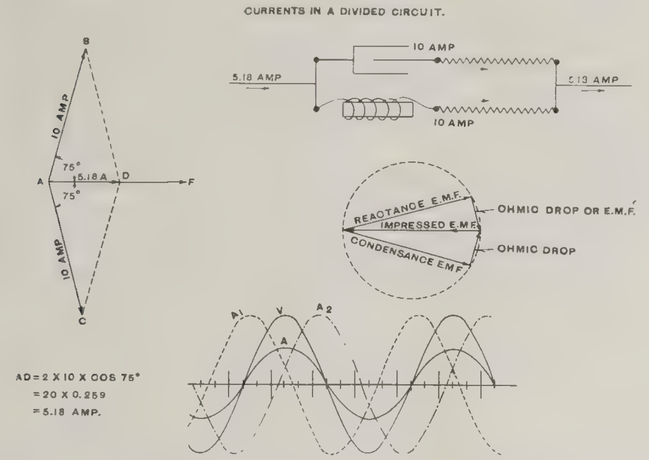


Fig. 15. Relations When Capacity and Reactance are in Parallel in Same Circuit.

The relation between effects of capacity and reactance are utilized for raising the power factor of the circuit by means of a synchronous motor. This condition is reached by overexciting the direct current field of the motor. This causes the synchronous motor to draw a leading current from the line, and inasmuch as the induction motors which are also connected to the line are drawing lagging currents, the leading current drawn by synchronous motor may be so adjusted that the resultant current drawn from the line is in phase with the generated voltage.

It may be interesting to note the peculiar effect of capacity and reactance in parallel branches of the same circuit. Let us assume as in Fig. 15 that we have one branch of a circuit with sufficient resistance and reactance to cause the current to lag behind the impressed electromotive force by an angle of 75 degrees, while in the other branch of the circuit we have resistance and capacity sufficient to produce a current leading the electromotive force by an angle of 75 degrees, and assume that the current in each case has a value of 10 amperes. If we combine these two currents in parallel we find a resultant current in the main circuit of only 5.2 amperes. In other words, the current in either branch of the circuit is greater than the current in the wire leading to the two branches. This would seem at first sight a little difficult to explain, but the truth of the matter is that the condenser is discharged into the reactance, and the reactance discharged into the condenser. In other words, there are local circulating currents which are greater than the current in the combined circuit of the two.

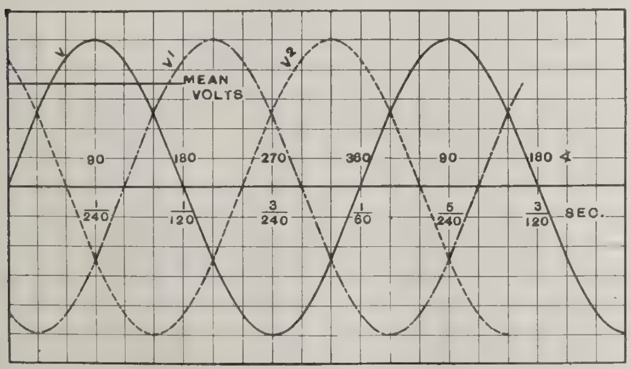


Fig. 16. Curves of Electromotive Forces for a Three-Phase Generator.

Up to this point we have limited our discussion to that of the single phase alternating current circuit. The question now arises—what is meant by a polyphase current, and how does it differ from the ordinary single phase current?

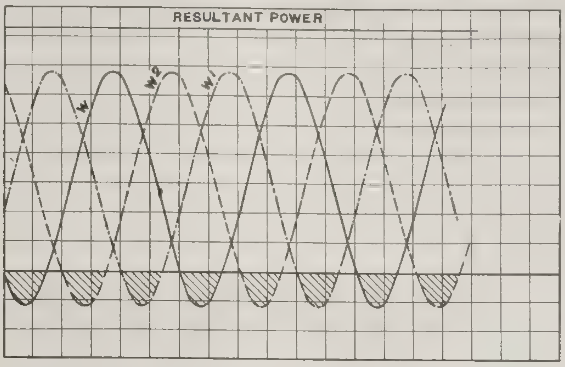


Fig. 17. Power Curves of a Polyphase Circuit.

The armature of a 3-phase generator is so wound and connected that the electromotive forces taken from the slip rings are not in the same phase. One electromotive force is identical with that taken from a single phase generator. A second electromotive force in the circuit lags behind this first one by an angle of 120 degrees, while a third lags behind the second by an angle of 120 degrees. This third electromotive force is in advance of the first electromotive force by 120 degrees. In other words, each electromotive force is 120 degrees behind one of the remaining electromotive forces, and 120 degrees in advance of the third. This is shown clearly in Fig. 16.

Assuming a circuit with a power factor of .707 there are shown in Fig. 17 the corresponding power curves of the polyphase circuit. If we add together all of the positive portion of the curve and subtract from this the negative portion, we obtain the straight line shown which is labeled "Resultant Power." From the fact that this resultant power is constant, the polyphase circuit in distinction from the single phase circuit is called one of constant or unfluctuating power. The same reactions go on as in the single phase circuit. Power is stored up in the magnetic field and then returned to the generator, but the conditions remain such that the power furnished by the generator at any instant from all three phases is constant while that furnished by any individual phase, if we may so consider it, is fluctuating in the same manner as in the single phase circuit.

The production of tungsten ore in 1913 was 1,525 tons, valued at $640,500; 1,330 tons, valued at $502,158, in 1912; 1,139 tons, worth $407,985, in 1911; and 1,821 tons, worth $832,992, in 1910. As heretofore, the Boulder County field, Colorado, was the largest producer, with an estimated output of 953 tons of ferberite in 1913, against 812 tons in 1912. Prices were better during the year than in 1912, and ranged from $6 to $7.50 per unit of 20 pounds of tungsten trioxide.

Conditions, Practice and Development in English Central Stations

BY CECIL TOONE, AN ENGLISH CONSULTING ENGINEER.

Setcion 6. Rate Considerations for Light and Power Service.

IN what follows a general review of rates for electric service as existing in the United Kingdom is presented, with occasional reference made to continental practice where this seems farther advanced along the same lines. The average consumer's opinion is that electrical energy should be sold at so much per unit, at all times and for any purpose. To electrical engineers it is needless to point out the why and wherefore of scientific tariffs, and as regards the public the attempt is hopeless.

In the present state of electrical development, bulk consumers can be supplied more cheaply than others, and it is an important matter to encourage day loads. Whether or not this will always be so is a question. Doubtless, as stations approach 100 per cent load factor, there will be less justification for encouraging day loads by reduced rates, and the percentage magnitude of the evening peak will become unimportant, but it seems inevitable that the small consumer should always represent a proportionally greater capital outlay by the station. At present the most logical and generally applicable rate seems to the writer to be a minimum annual charge determined by the capital cost of the consumer to the station, and a charge per unit which shall be the same for all consumers. Perhaps the public may be educated up to this system—which is already in extensive use—but it is undeniable that they now regard any other than a flat rate with suspicion. In the moving picture field, for instance, the distinction between lighting and power rates has caused much dissatisfaction. In many small provincial towns the moving picture load is confined to evening hours and represents an appreciable fraction of the whole demand, yet it is impossible to convince showmen that the best terms to which they are at present entitled are theater rates. A favorite argument is that gas is obtainable at so much per cubic foot at any time and in any quantity, the only distinction being a comparatively small discount to wholesale users. Why, then, ask the exponents of this creed, cannot electricity be supplied on similar terms? From the consumer's point of view—which must be considered—it certainly does seem unfair that he should be penalized for the deficient development and defective system of electricity generation and supply. It is up to supply engineers to increase the demand from their mains, to install storage cells if necessary, and to select generating units and methods and means of distribution so that the fixed charges against every consumer are as nearly as possible proportional to his consumption. This must be done while allowing present consumers as much freedom as possible in nature and extent of demand, and ultimately it should be possible to supply everyone at a flat rate, with perhaps a sliding scale of discount to large consumers. This form of rebate is understood by everyone, though it is often quite illogical.

EXISTING RATES.

In many, if not most, central station areas in this country, alternative rates are available for domestic service, and the fact that the option of a flat rate is given where a scientific tariff is also in vogue inspires confidence in the latter. The supply authority can, of course, arrange that the flat rate yields them an adequate return in any ordinary case. The most common rates are flat rates and charges on the Wright maximum demand system, different terms being arranged for domestic lighting, theaters, shop lighting and power. Generally the retail power rate is about half or one-third the lighting rate, but special arrangements are invariably made for bulk supply.

Restricted hour or two-rate schedules are popular. The former is particularly useful in supplying small industrial loads, since it definitely improves the station load factor while rendering energy available to the consumer at prices much lower than could otherwise be afforded. In Bradford, for instance, consumers prepared to dispense with supply between 4 and 6 p. m. from October to February can obtain current for lighting and power at 3.8 and 1.4 cents per unit, respectively. Two-rate systems, in which different flat rates are charged between certain hours of the day, irrespective of the application of the current, are fairly popular, particularly on the continent. Time switches and two meters, or a meter with two recording trains, are needed in such cases, but their cost is less than that of an installation with two meters and dual wiring.

Various applications of the Hopkinson differential principle of charging are to be found in the Wright, Norwich, Detroit, contract demand, Glasgow, Metropolitan and Telephone systems. Space limitations prevent detailed treatment of these. Readers who have not already done so should certainly consult Mr. Seabrooke's classic paper before the English I. E. E. (Vol. 48, pp. 376-412). Mr. Seabrooke advances many arguments in favor of the telephone tariff. In this rate a primary charge is made of so much per annum on the lighting circuit wattage—excluding convenience and decorative lamps—plus, say, 2 cents per unit for all energy consumed for lighting or other purposes. The use of "other apparatus" is distinctly encouraged, and the system has given good results in the Marylebone area. The arguments against this system are fairly presented by the discussion on the above paper.

The maximum demand system is extensively employed in the United Kingdom—generally in the form of so much per unit for the first hour's (or two hours', etc.) use per diem at maximum demand, and then a much lower price per unit for additional energy. Essentially the same system is often disguised as a fixed charge per annum for each lamp of specified candle power, plus a certain rate per unit up to an amount equal to the fixed charge, and then a much smaller charge for further units. The true maximum demand system encourages uniformity of demand, but, unfortunately, goes further and tends to restrict consumption, the consumer fearing to incur unwittingly an inordinately heavy bill. In order to distribute fixed and running charges equitably between various consumers, Kinzbrunner suggests (for English conditions) a sliding scale of 1.9, 3.0, 6.6 and 11.4 cents per unit, according as the average daily demand extends over 10, 6, 2 or 1 hours.

Table I is interesting in connection with the question of minimum fixed charge per annum for domestic supply. The data presented are based on a valuable mass of statistics published a year or two ago, and relate to residences and flats of various sizes. The bracketed numbers indicate the number of cases on which averages are based. Up to 10-roomed dwellings the averages are very useful; for larger establishments, averaging becomes risky.

TABLE I.—MINIMUM FIXED CHARGE PER YEAR FOR DOMESTIC SERVICE.

	Residences		Flats	
No. of rooms.	Average Kw. charge per room per yr.	Total Lighting watts installed.	Average Kw. charge per room per yr.	Total Lighting watts installed.
5	$3.30	547 (8)	$4.75	625 (50)
6	5.20	665 (32)	4.85	700 (62)
7	5.25	798 (49)	5.30	880 (58)
8	5.95	1090 (47)	7.30	1047 (19)
9	5.20	1161 (44)	6.50	1291 (6)
10	6.15	1540 (75)		
11	6.90	1770 (41)	4.75*	1445 (7)
12	6.70	1870 (70)		
14	6.00	2310 (45)		
18	7.30	3200 (14)		
22	7.70	4246 (8)		

* Appears to be abnormally low.

CONTRACT RATES.

Contract rates at so much per lamp per annum were used in the early days of electricity supply as being the simplest rate possible, and as requiring no meters, which were then costly and unsatisfactory. Today a return to this system of charging is being made in the supply of large numbers of industrial workers, owing primarily to the simplicity of the system and the predetermined liability which it places upon consumers. Contract tariffs in conjunction with current limiters (to prevent waste and abuse) and no meter have proved very useful in encouraging small consumers, and the central station is spared the cost of providing meters and saved the loss often incidental to the use of small meters. Elimination of meter reading and upkeep, capital charges on meters, and cost of billing may easily save $1.00 or $2.00 per consumer per annum, besides saving loss to the station or penalization of consumers by negative or positive meter errors, the importance of which is exaggerated where large numbers of small meters are in use. Meter rent which must be paid directly or indirectly—also represents a disproportionate item in small installations. Experience proves that current limiters meet with consumers' approval while safeguarding fully the interest of the central station. An interesting form of limiter has been introduced which enables consumers to exceed the prescribed maximum demand a certain number of times per quarter on insertion of a coin in the apparatus; an automatic thermal device restores normal limiter working after a certain interval.

Contract tariffs up to a certain predetermined demand and a special rate per unit thereafter are in considerable use on the continent, a special meter being required. Generally speaking, complex tariffs and automatic apparatus for use therewith find greater application in France and Germany than here. It is only fair to add that very good results are generally achieved. This supports the contention that for some years to come special tariffs must be devised to suit the conditions and encourage development in each particular supply area.

DOMESTIC AND INDUSTRIAL PRICES PER KW. HOUR.

Average lighting tariffs vary from 8 to 10 cents per unit in small towns in this country and from 6 to 8 cents per unit in cities. Current for power purposes is usually sold retail at from 3 to 6 cents per Kw.-hr. in small undertakings and from 2 to 4 cents in cities. An important association of engineers (the "Point Fives") was formed in 1912 by those who supplied energy for domestic purposes at 0.5d. (1.0 cent) per Kw.-hr. Originally there were eight members; now there are seventeen (representing as many supply undertakings). The technical importance of the association has increased rapidly. Doubts have been expressed as to whether sufficient account has been taken of standing charges by some of the members and as to whether it is wise to supply at 1.0 cent when there is so much business to be done at 2.0 cents, and the efficiency of apparatus constantly increasing. It would certainly be too much to say that supply at 1.0 or 2.0 cents per unit is justifiable in all cases, but the stability and good work of the "Point Fives" are beyond doubt.

Special prices are quoted to large power consumers; indeed, an infinity of concessions are granted (and justified) in individual cases. Bulk supply is usually at high tension, and the price charged varies according to the total consumption, the load factor, and whether the consumer or the supply authority installs and maintains the necessary transformer and switch gear, etc. Simple tariffs are much less important than in domestic supply. Where a large amount is concerned, the works manager is prepared to go to much trouble to secure the most favorable quotation for the energy he requires, and the sliding scales in vogue take into account the total consumption per annum, and usually the load factor, or, what amounts to the same thing, the units per annum per Kw. of maximum demand.

There has been much discussion as to means whereby industrial consumers operating a load of poor power factor may be penalized for the extra copper which they require to be placed in generators and mains without (at present) yielding any return to the station thereon. Arno (Italy) has devised a "complex" meter to record kilo-volt-amperes, and tests are being made in North Italy, charging consumers so much per unit for true power and so much for wattless current. There is some doubt as to the present legality of this system, but its equity appears undeniable.

In Glasgow large power users are supplied at rates varying from 1.5 to 1.0 cents per unit. In the South Wales coal fields energy is supplied at from 10.7 to 0.7 cents per unit (on a Merz scale), according to the load factor of the demand. On the Tyneside and Clyde and in the North Metropolitan area large consumers are supplied at 0.6 to 0.7 cents per unit. The Lancashire Power Company supplies at 0.9 cents per unit, plus a fixed charge ranging from $30 to $15 per Kw. per annum, and the Yorkshire Power Company supplies its largest consumers at 0.5 cents per Kw.-hr.

Charges for power supply in a typical provincial town of medium size range from 3 cents per unit for loads of 14 per cent load factor to 2.34 cents for 25 per cent and 2.0 cents for 40 per cent load factor. Under restricted hour limitations, power is supplied at 2 cents per Kw.-hr. up to 5,000 units per quarter and at 1.75 cents for 25,000 units or over. The ordinary power tariff is here 4 cents per unit, with 1 per cent rebate for every 500 units up to 1,250 per quarter, and thereafter 3.0 cents per unit, flat rate.

RENTING OF MOTORS.

This is a matter of great importance in developing all industrial motor loads. By undertaking the hire or hire-sale of motors, a supply authority insures the use of satisfactory machines and obtains clients who—by their conservatism or lack of capital—would hardly install motors under any other circumstances. Once a footing is obtained for electric power, its development is rapid and automatic. Payments in respect to the motor may be included in the price for current, if the latter is sold on the fixed plus unit charge system, but it is generally better to keep the motor payments quite distinct. Opinions differ as to whether the station should maintain and repair machines leased on the above terms.

TYPES OF METERS.

For direct current circuits, electrolytic and magnetomotor meters of the unbraked ("O. K."), braked unipolar (mercury), and watt-hour types are all in use. Thomson dynamo-motor and Aron meters are user for either direct or alternating current measurements; induction (watt-hour) meters are suitable for alternating current only. Ampere-hour meters—particularly the Bastian and Wright electrolytic types and Chamberlain and Hookham mercury-motor meters—are most used in d. c. systems. The constancy of supply pressures is such that these meters can safely be calibrated to read watt-hours. The great advantage of ampere-hour meters is the elimination of shunt losses which are so serious where many small meters are used. For instance, a small German undertaking found recently that, by using watt-hour meters, it was losing about 35 units per annum on each instrument, while in many cases the consumer's demands average only 30-35 units per annum. Such a loss is naturally sufficient to determine the profitable or unprofitable operation of a small undertaking.

Peak meters, average demand meters, and double and multiple tariff meters are in use, particularly on the continent. Prepayment meters are very popular in industrial districts, flats, etc., where tenancies are short and bad debts liable to be contracted. Prepayment meters are used in about 100 supply areas in this country, and in fully half of these cases the Mordey-Fricker instrument is used. The use of token meters avoids locking money up in meter cash boxes, but imposes unreasonable hardship or inconvenience on the poorest consumers who must needs "invest" their money which can ill be spared or buy tokens one or two at a time.

AGRICULTURAL AND VILLAGE RATES.

Overland distribution schemes in this country are confined to industrial and mining localities, and there being few waterfalls in agricultural districts worth electrical development, little progress has yet been made in the application of electricity to agricultural power duties. On the continent—particularly in Switzerland, France and Germany—good results have already been obtained and special rates arranged to suit local circumstances. There is a tendency to perform grinding and root cutting, etc., on winter evenings, and during harvest it is difficult to avoid abnormal peak loads. The best system which the writer has met with depends on a group of farmers contracting for a certain maximum demand at so much per annum and then lending each other their "right of demand," just as they may profitably purchase and work cooperatively the heavier electrical equipment needed.

In village supply undertakings, since a plant often runs only during lighting hours, the rate per unit is necessarily relatively high in order to cover during this short period the whole daily share of the fixed charges. If agricultural or other power loads (pumps, saws, shopkeepers' and tradesmen's machines, etc.) can be supplied during the day, the case is altered. Large houses in the neighborhood entertaining large parties at intervals may complicate the case considerably by requiring exceptional standby plant in the station. From 12 to 16 cents per unit is often obtained in village supply undertakings. At 12 cents electricity can generally compete with gas at $0.84 per 1,000 cubic feet, but it often happens that a small central station can be operated profitably where no gas works could find a living.

Details of Electrical Decorations for Atlanta Meeting of Shriners.

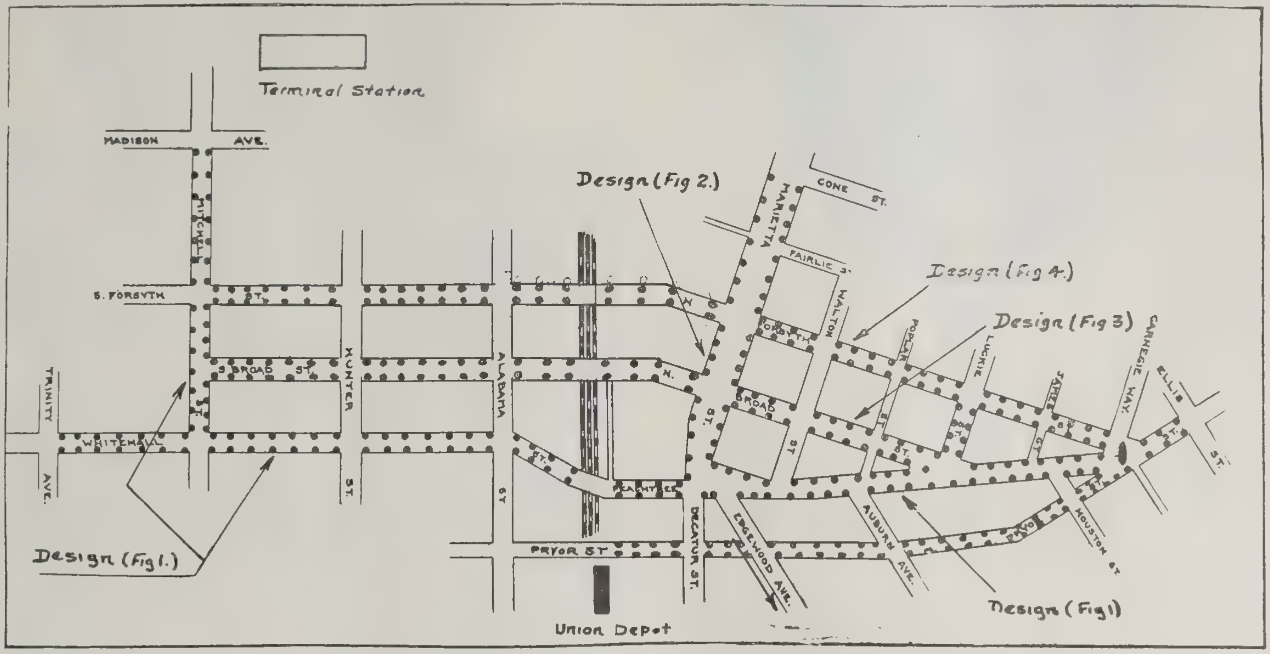
BY CARROLL B. M'GAUGHEY, CHAIRMAN OF COMMITTEE ON ARRANGEMENTS.

For some weeks past a committee has been at work on special electrical decorations for the annual meeting of the Imperial Council of the Ancient Order of the Mystic Shrine at Atlanta, Ga., May 11th to 16th. These decorations will make use of the extensive white way installed in Atlanta, and embody designs that are not only individualistic and artistic, but in keeping with the latest and best in the art of electrical display and illumination. Inasmuch as none of the electrical decorations planned have been installed at this writing, they can only be shown by means of the designs on which the decorations will be based, which, however, indicate the effects produced very conservatively, as tests of models already made have shown. The nature of the particular designs and the layout of the display and decorations are as follows:

As shown on the map presented herewith, from the Terminal Station on Mitchell street in Atlanta to Whitehall street, and along Whitehall and Peachtree streets to Ellis street, and on one block of Luckie street between Peachtree and Forsyth, the style of design shown in Fig. 1 will be used, mounted on the white way posts. There will be 137 of these designs installed on these streets. This design is 6 feet from the arm of the post to its top, and 30 inches wide, with the camel in the center of the enclosure 14 inches high. The design is made of sheet iron, painted white, with the camel molded from a special plaster composition and painted natural color. The Shrine emblem is punched in the metal, with red celluloid covering it, giving a transparent appearance and standing out in contrast with the white of the design when lighted. On two sides of this design appear the word "Welcome," and on the remaining two sides the word "Yaarab," the name of the Atlanta temple. The name of other temples will appear on the other posts along Peachtree street. This design is so arranged that when the top globe of the white way is removed it exactly fits the globe support and is illuminated by the center light.

In Fig. 2 is shown the type of design to be used on Marietta street and North Pryor street from the Union Station to Edgewood avenue. Of this type 80 will be installed. In this design the emblems are molded from special composition, painted white, and supported on metal bases painted a green color. The large crescent is 36 inches high, and placed on the center light support of the white way post, with the smaller designs on each of the four other supports. From the top of the center crescent hangs a 500 watt lamp, completely frosted, while in the center of each star of the smaller emblems a 25 watt tubular, all-frosted lamp is mounted. All of these lights are fed from the regular post wiring circuits, the design being so wired with plugs that connections can be readily made.

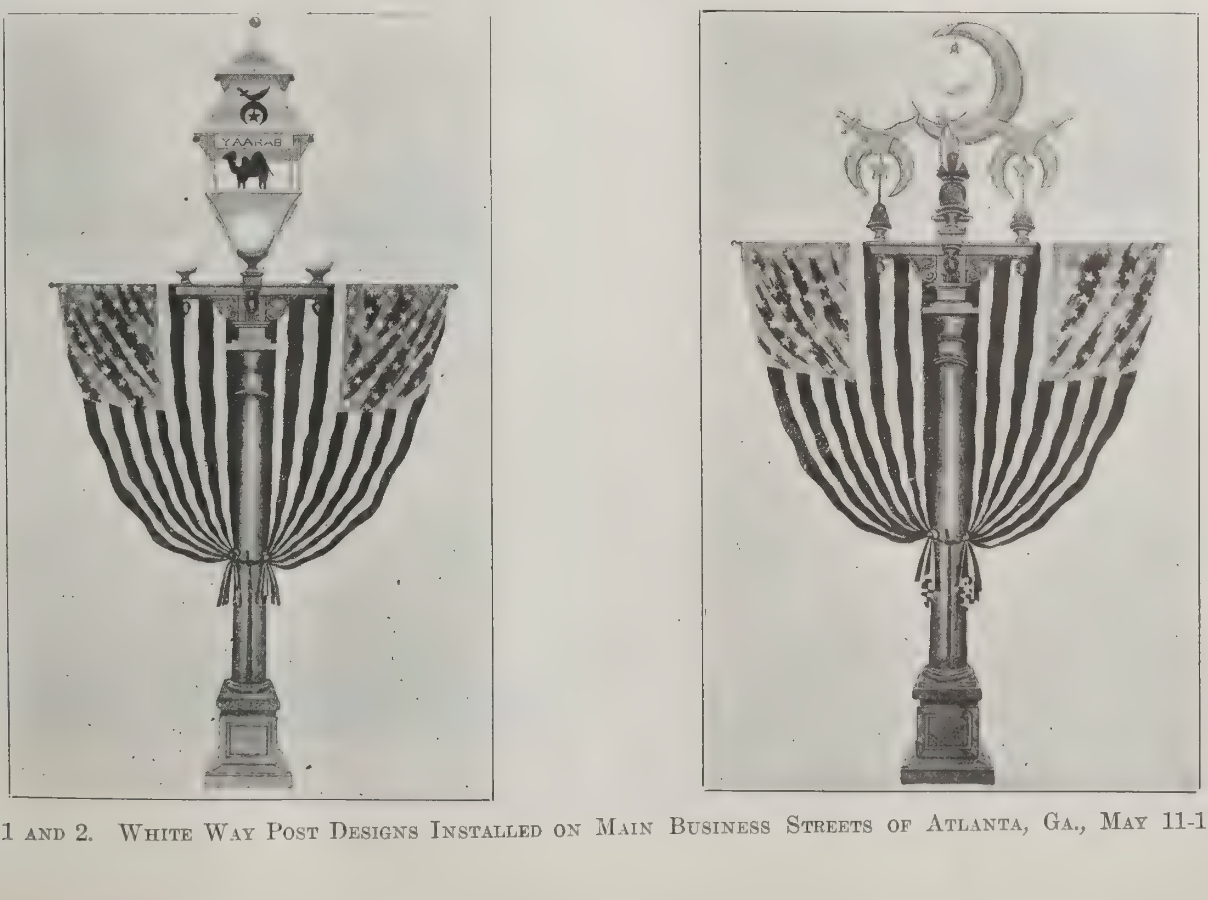
In Fig. 3 a post design for Broad street is shown, consisting of a metal pyramid 4 feet high and 3 feet wide at the base. The Shrine emblem shows red by being punched through the metal and covered with red celluloid, as in the design of Fig. 1. The pyramid is painted gray and draped in the Shrine colors. Of this design 30 will be installed.



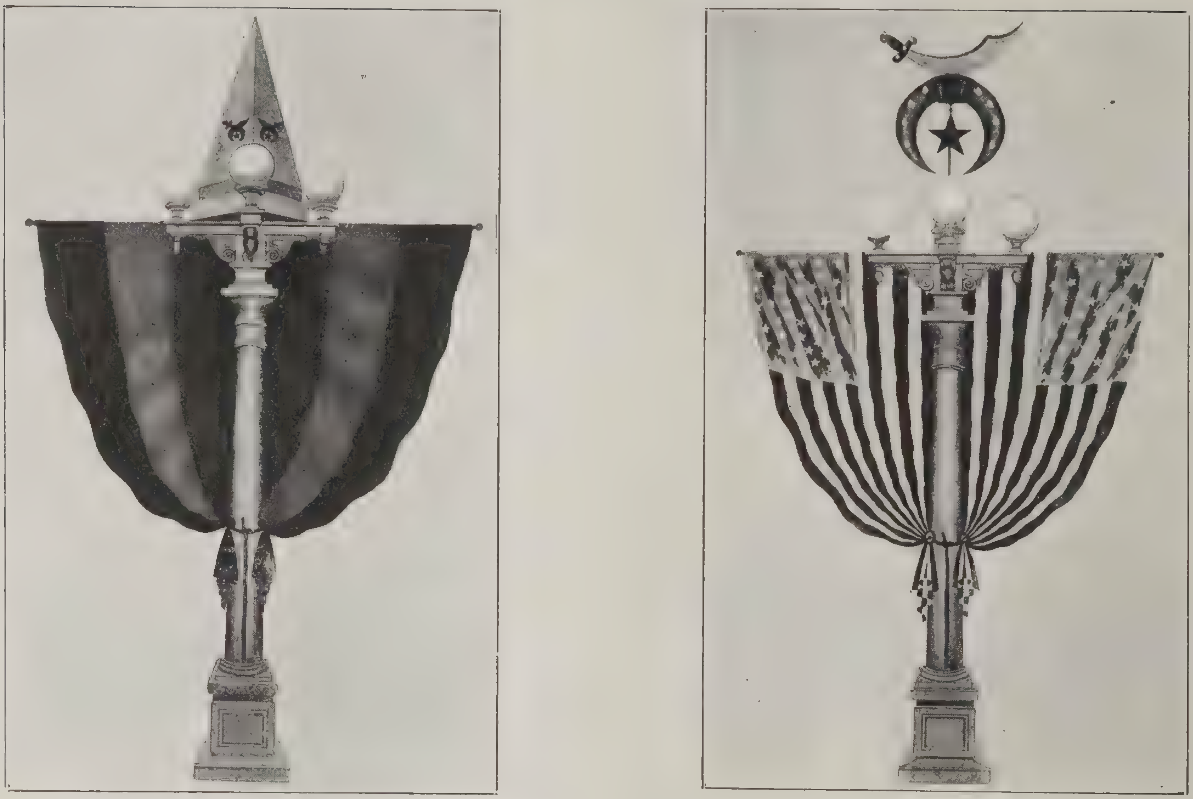
Map of Atlanta White Way Showing Location of Special Shrine Illumination.

The design shown in Fig. 4 will be used on Forsyth street. It is made of the same special composition as the other models, painted in Shrine colors and studded with lamps. The emblem is 36 inches high by 24 inches across, double face, and illuminated with 36 lamps. Of this type 60 will be used.

In addition to these white way post designs, at each four-way street crossing—25 in all—a 42-inch double-face Shrine emblem, illuminated by 50 lights, will be supported on span wires across the street. At what is known as "Five Points" in Atlanta, the intersection of Peachtree, Marietta and Decatur streets and Edgewood avenue, a large 15-foot star will be placed. The body of this star is studded with amber lamps, 300 on each side, with the Shrine emblem at the center illuminated by different colored lamps suitable for the Shrine color scheme. This design is supported 50 feet above the ground by span wires across the street. From the lower center of the large star festoons of electric lights are strung to the white way posts on each side of the street and between these posts, forming a canopy



Figs. 1 and 2. White Way Post Designs Installed on Main Business Streets of Atlanta, Ga., May 11-16.



FIGS. 3 AND 4. OTHER DESIGNS INSTALLED FOR CONVENTION OF SHRINERS.

effect. The lights of the festoons and those of the body of the start will be operated by a flasher and present a scintillating effect. In this design 1,500 lights will be used.

From "Five Points" down Edgewood avenue to the Annuity Building, on each trolley span, three 36-inch doubleface metal Shrine emblems will be suspended, each illuminated by 40 8-candle-power red lamps. On Broad street, Marietta street and Mitchell street one of these emblems will be suspended in the center of each trolley span, lighted with white lights. On Peachtree street, from Ellis street to Harris street and the Capital City Club, another interesting scheme of lighting is to be used. At intervals a large star with a 500 watt lamp at the center is to be suspended on each side of the street from a wire span connected to the trolley poles. Twenty of these spans are to be installed for the purpose of increasing illumination.

On the Masonic Temple a huge Shrine emblem has been erected, some 20 feet square, illuminated by 1,000 lamps. The lamps in the star of the emblem are red, with those in the other parts of a color suitable to bring out the Shrine colors. This emblem is supported 110 feet above the ground and can be seen at night from a number of points about the city where tall buildings do not obstruct the view.

From the layout of the Atlanta white way, shown herewith, only for the most prominent business streets and thoroughfares, a good idea can be secured of the extent of the illumination to be used. In connecting up some of the designs used, and especially the festooning at "Five Points," use has been made of a provision in the installation of the white way. This provision consists of an extra feed wire at each post brought out at the bottom of one of the arms. On any one side of the street these extra feed wires are connected alternately to the positive and negative line feeder, so that a festoon of lights can be arranged between any two posts on any side. In addition, the extra feed wires to the posts on any one side of the street are so connected as to be of opposite polarity and enable festooning across the street from post to post.

In view of the fact that some 10,000 lamps are used in the electrical decorations, representing a load of 400 Kw., the matter of distributing the load properly has been one that has been given careful study. The arrangements are as follows: At cross streets multiple street arc circuits (D. C. 110 volts) are to be used. For the large emblem on the Masonic Temple a special A. C. cut-in is used. For the large star the regular underground commercial lighting is used. For the Edgewood avenue and Broad street decorations the trolley circuit (550 volt D. C.) is used, and the remainder of the illumination from white way circuits, 220 volts D. C.

Those making and furnishing the designs and models are: Dowman-Dozier Mfg. Co. (metal work), Atlanta; Koppe & Steinicher (composition work), Atlanta; Southern Iron & Equipment Co. (cast iron bases), Atlanta; Greenwood Advertising Co. (large 15-foot star and emblem), Knoxville, Tenn.; Goodman-Weeks Co. (flags), Seattle, Wash.; McGaughey Electric Co. (electrical work), Atlanta. The electrical decorations represent an expenditure of around $35,000.

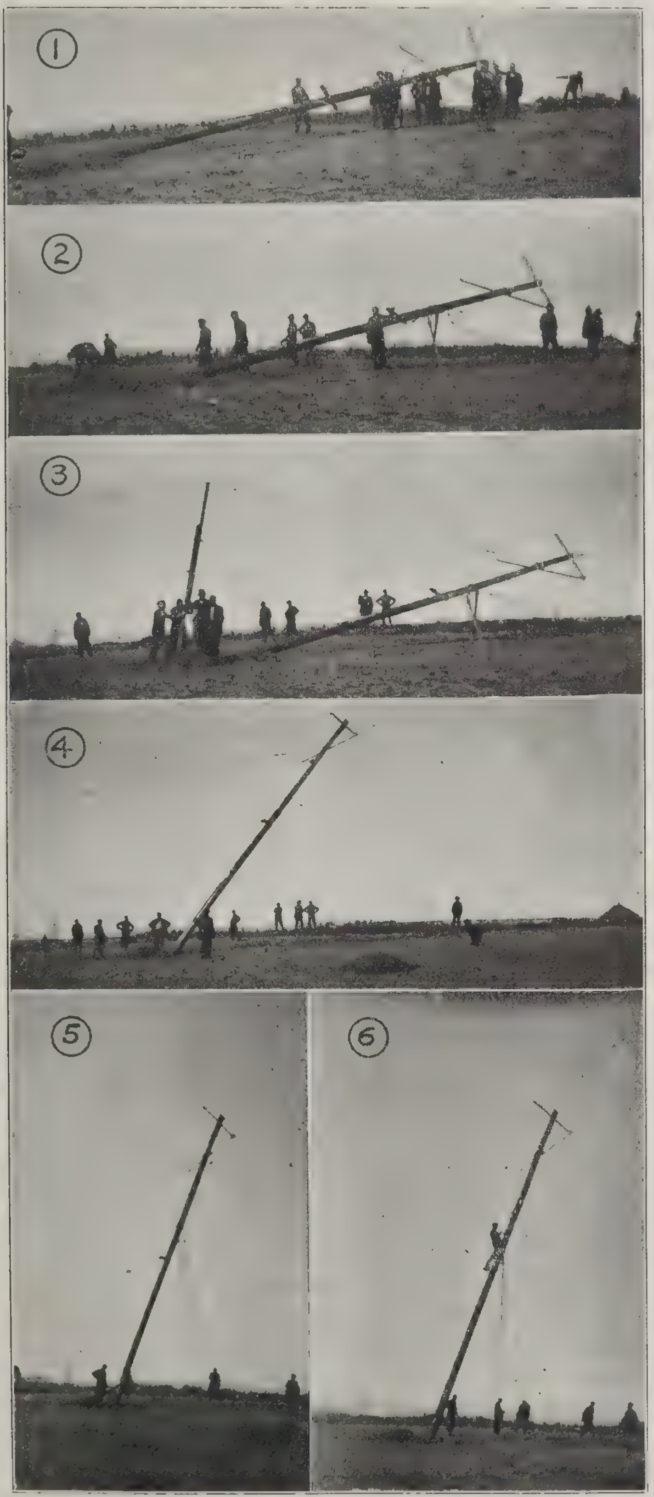
[Note.—The electrical committee in charge of the decorations described herewith is composed of the following: Carroll McGaughey, McGaughey Electric Co., chairman; H. L. Wills, Georgia Railway & Power Co.; P. C. Gillam, W. E. Carter Electric Co.; L. J. Daniel, Daniel Brothers Clothing Co.; and Dr. M. E. Turner, dentist.

Mr. McGaughey has been responsible for the design of the entire scheme of illumination, and, with the assistance of Mr. Gillam, supervised the construction of the models for the designs and the installation of same, and to him belongs the credit of much, if not all the success of the electrical arrangements, now generally conceded to be not only the most elaborate, but the most original of any similar meeting.—Editor.]

Setting 50-Ft. Poles at a Cost of Sixty-Five Cents Each.

BY J. O. HARDIN, OF ENGINEERING DEPARTMENT, GEORGIA RAILWAY AND POWER COMPANY, ATLANTA, GA.

A scheme for setting heavy creosoted poles is now used by the construction force of the Georgia Railway & Power Company which has proven to be a great time-saver and thus materially reduces the installation labor cost in connection with the construction of pole lines. The scheme is shown in the accompanying illustrations in the stages necessary to explain same. The poles are handled and distributed along the right-of-way by the use of high-wheel pole carts and ox-teams, and the first step in setting is the gaining of the pole by use of a wooden template and assembling of wish-bone crossarm, telephone arms and ground line bayonet by a gang of three men. The pole is then ready to place in the seven-foot hole, as shown in Fig. 1. The erection gang lifts the pole, as shown, and places under it a mule pattern pole support (dead man) in the position as shown in Fig. 2. Two side guys, consisting of small double-block tackle, are then fastened to the pole just above the telephone arms and anchored to a six-foot iron digging bar about sixty feet from the base of the pole. The fall lines of these tackles are handled by two men, one to each line.



Figs. 1 to 6. Stages in the Setting of Poles by Method Used by Georgia Railway & Power Company.

The hoisting cable used is a $5/8$-inch hoisting rope, supported 15 feet above the ground by a light *A* frame placed near the butt of the pole, as shown in Fig. 3. Power is supplied to this hoisting cable by a team of two mules, acting through a pair of double blocks, using a one-inch manilla rope. The stationary end of this tackle is anchored to the base of the preceding pole, the fall line being guided in any direction by a small snatch block. The hoisting cable is shown taught in Fig. 3. In Fig. 4 the pole is show half-way up, held in position by the side guys. The foreman of the gang stands immediately in line with two poles already set and directs the handling of the side guys so as to keep the pole, during the time of being erected, in a vertical plane. This same foreman lines up the rigging before the hoisting is started. In Fig. 5 the pole is shown in place in the hole, and in Fig. 6 the lineman is taking off the rigging.

By use of this scheme a construction gang in one day of nine hours set 45 creosoted 50-foot poles, which, with cross-arms assembled, had an average weight of 4,000 pounds each. The line extended over a distance of one and one-half miles, and each pole required an average of eleven minutes to set, a large part of this time being consumed in attaching and moving rigging from pole to pole. The pay roll of the construction gang was $30 per day, including teams and foreman, making the cost of erecting each pole 65 cents. This was no special record, for as many poles have since been set on an average in one day of nine hours.

Tri-State Water and Light Association of the Carolinas and Georgia Extends Field to Include Entire South at Atlanta Convention.

The Tri-State Water and Light Association of the Carolinas and Georgia held its fourth annual convention at Atlanta, Ga., on April 16 and 17. This association was organized at Columbia, S. C., in 1911, for the purpose of advancing knowledge of the supply of water and light to the public, and the exchange of information and ideas among managers and superintendents of municipal plants. Conventions have been held heretofore at Salisbury, N. C., and at Charlotte, N. C., Atlanta being chosen for the fourth meeting on account of the convenience of its location for Georgia members, and for the reason that certain Atlanta plants would lend special interest to the association membership. An important development at this meeting was the adoption of resolutions authorizing the executive committee to change the association name to Southern Water and Light Association and make this organization one that will serve the municipal interests of the entire South, instead of three states, as heretofore.

The Atlanta convention was attended by some 200 members and guests, and a program arranged for four sessions carried out. On Thursday, the 16th, at 10 o'clock, the first session was opened by an address of welcome by Mayor James G. Woodward. The response to the mayor's welcome was delivered by Hon. W. F. Stieglitz, councilman of the city of Columbia, S. C. The annual address of the association president was then read by Mr. A. J. Sproles, after which Joel Hunter, of Atlanta, spoke on "Accounting Systems for Water and Light Departments," and L. W. Carnegy, of the General Electric Company, read a paper on "Watthour Meters." This ended the morning session.

At the afternoon session of Thursday a paper was presented on "Forestry and Water Resources" by H. S. Graves, chief forester of the Department of Agriculture, Washington, D. S. In this paper it was pointed out that in the Carolinas and in Georgia alone over $50,000,000 is now invested in cotton mills run by water power directly or by electric power generated therefrom, and this is only the bare beginning in electrical development. The 2,000,000—or, as some claim, 3,000,000—horsepower available in the streams that flow from the Appalachians to the Atlantic, when developed, would mean an investment in hydro-electric plants of upwards of from $200,000,000 to $300,000,000, earning annually from $40,000,000 to $60,000,000 at a conservative estimate, and saving the South on its coal bill alone some $15,000,000 to $20,000,000. The author declared that the South today is standing on the threshold of a vast industrial development. The extent of this development, and consequently the advancement and prosperity of the South itself, depend very largely on two factors—the production of raw material from the farms, forests and mines, and the protection and development of water resources. The South is pre-eminently favored in both these respects. It is not merely the great amount of navigable waters stretching far back into the different states, available for cheap transportation, but vast water powers which are rapidly transforming the South into a manufacturing as well as an agricultural section. He appealed to members of the association to prevent serious injury to Southern industrial developments by affording better protection for forests, farms and mine resources.

The afternoon session was closed with a paper on "Water and Its Purification for Industrial Purposes," by M. F. Corin, of Philadelphia.

At the morning session on Friday the following papers were read: "Relation Between Water and Fire Departments," by M. B. Sanders, of Greenwood, S. C.; "The Relations Between Boards of Health and Purification Plants," by F. A. Coward, of Columbia, S. C.; and "The Progressive Spirit in the Field of the Association," by E. M. Anderson, of Abbeville, S. C. Following this paper, the election of officers took place, and the following were chosen to serve during the coming year: F. C. Wyse, of Columbia, S. C., president; J. W. Neave, of Salisbury, N. C., first vice-president; Hugh Hill, of West Point, Ga., second vice-president; E. R. Fluke, of Sparta, Ga., third vice-president; J. C. Barnwell, of Rock Hill, S. C., secretary and treasurer for the association; B. F. Erwin, of Atlanta, secretary and treasurer of Georgia; F. G. Swaffield, secretary and treasurer for South Carolina; Will Blackwell, secretary and treasurer for North Carolina. Much credit is due Mr. B. F. Erwin, of the Hersey Manufacturing Company, for the success of the Atlanta convention as chairman of the committee on arrangements. His election as secretary for Georgia places him in a position to do a valuable service for the association.

The afternoon on Friday was spent visiting and inspecting certain interesting places and plants about Atlanta, the following places being visited: Federal prison, Cyclorama of the Battle of Atlanta, Hemphill water works station, sewage disposal plant, Atlanta gas plant and the plant of the Georgia Railway & Power Company. Following this trip, an old-fashioned Georgia barbecue was held at the Atlanta water works.

During Friday evening William Rawson Collier, sales manager of the Georgia Railway & Electric Company, of Atlanta, delivered an address on "Debts." Mr. Collier's address was well received and decidedly interesting because it took up some of the features of mutual relationship between public and public service corporation that are frequently overlooked by those who know most about the troubles of the public, but little about the production and sale of electric light and power. He divided his discourse into three sections: (1) What do we owe the public? (2) What does the public owe us? (3) What do we owe our stockholders? Under the first heading he pointed out that, by virtue of permission on the part of the public to use the streets for erecting poles and laying underground cables and water mains, and by virtue of consuming the product of the central station company, the public is due good service, prompt attention to troubles, courteous answers to requests, and action in all ways becoming a good citizen. He further stated that the public is due a low rate for the product they buy from the central station, which matter in the state of Georgia is looked after by a Public Service Commission to the mutual benefit of both the customer and the public service company.

Under the second heading Mr. Collier said that usually the public feels that it has paid its debt to the public service company when its bills are paid, when, in point of fact, this is the smallest thing it does owe. It owes the company furnishing the essentials to modern living—water and light—a friendly feeling, active co-operation and the hearty good will that is necessary in every contract if both parties are to profit by the agreement. He made it clear, in commenting on these points, that the public is not to be expected to quietly submit to poor service, exorbitant rates, indifferent treatment, and the like, it being emphasized that first-class service at equitable rates is the first essential.

Under the topic, "What Do We Owe Our Stockholders?" Mr. Collier endeavored and did show in an able manner not only why the company must have dividends, but why it is entitled to same. He first pointed out that before the paying of dividends by the company comes the paying of the debt it owes the public already mentioned. In taking up the further discussion on this point, he explained the essentials of proper plant design and efficient operation, and the cost of plant equipment to be able to furnish the character of service demanded. He showed how it is that the controlling influences in regard to rates are not price of coal and price of labor, but the price of money that is important and governs the matter of rates in any locality. In this connection he showed a number of charts and diagrams explaining peak load and load factor.

Following Mr. Collier, Mr. W. M. Fambrough, of Atlanta, delivered a paper on "Municipal Improvements," outlining some of the problems involved. The convention then adjourned until next meeting, which will be held at Asheville, N. C.

Georgia Electrical Contractors' Association Organized.

On April 15th, at Atlanta, Ga., some 50 electrical contractors, jobbers and manufacturers throughout the state assembled at Hotel Ansley for the purpose of working out the basis of an organization and the creation of a state section of the National Electrical Contractors' Association. For some time previous to this date Mr. G. W. Hill, a representative of the National Electrical Contractors' Association, of Utica, N. Y., and a committee of seven Atlanta electrical contractors had been at work in Atlanta and surrounding cities enlisting the cooperation of contractors in this movement, with the result that the proposed section was created with sixteen enthusiastic members, and the proceedings of the meeting of April 15th will constitute those of the first annual meeting of the Georgia Electrical Contractors' Association. The organizing committee was made up of the following members: T. H. McKinney, chairman; G. E. Russell, of Russell Electric Co.; J. M. Clayton; C. B. McGaughey, of McGaughey Electric Co.; W. L. Bailey, of Bailey Electric Co.; S. D. Woodward, of Woodward Electric Co.; and J. F. Bryan, of Bryan Electric Co.

An elaborate program was arranged for this occasion, providing for a morning and an afternoon session, with a banquet and theater party during the evening, the former being given the contractors by the Atlanta jobbers and manufacturers and the latter by the Atlanta electrical contractors.

The morning session was called to order at 10 o'clock, and Mr. Hill was elected to preside and explain the object of the meeting. He outlined in a very complete manner the organization movement among electrical contracting interests throughout the country, and explained the work of the national organization. The session was then formally opened by an address of welcome by A. F. Giles, manager of the General Electric Company, Atlanta, Ga. After appropriate remarks of greeting, Mr. Giles, in his characteristic style, reviewed the benefits of proper organization and the needs of the electrical contracting business from the standpoints of contractors, jobbers and manufacturers. He complimented those engaged in the electrical contracting business as carrying on a work requiring recognized technical ability and a broad business knowledge, stating that the electrical contractor must first be an electrical and constructing engineer, then a salesman of his construction, and finally a financier and a collector. He emphasized the need of estimating and accounting in the business to balance the essential requirements named, in order that those engaged in electrical construction may know the reason why they are or are not making money.

Following Mr. Giles' address, one on "Co-operation" was delivered by Mr. G. E. Russell, of the Russell Electric Company, Atlanta. This talk was pronounced by those who heard it as a strong and clear-cut presentation of the electrical contracting business, its difficulties and remedies. An abstract follows:

ADDRESS BY GADSDEN E. RUSSELL.

"The subject of co-operation is one that is being discussed every day in the commercial world, and, instead of being threadbare, its importance is being recognized and its possibilities being realized through scientific business methods. Co-operation is of no value in any endeavor unless the definite means and methods which it involves are applied, but when applied such means and methods reduce the cost of carrying on any business.

"Contrary to the opinion of some, intensive competition does not reduce the cost of work to the consumer permanently, for eventually every dollar lost by the electrical contractor, jobber and manufacturer is paid by the consumer in one way or another. If a contractor takes work at too cheap a price, it is only a question of time when he will lose all the money that he has put into the business and either quit the work or go into bankruptcy owing his competitors in proportion to the credit extended and causing a loss to the jobbers and manufacturers who made his existence possible while it lasted.

"Electrical contractors cannot be successful unless their legitimate competitors are successful," declared Mr. Russell, "and each and every one secure their work on the basis of profit instead of any glory that may be involved. The fact exists that too often electrical contractors take work simply to hang their name upon a building and thus place their money at the service of someone who is already wealthy and does not appreciate the actual conditions. There is co-operation above, below and all around the electrical contracting business, but very little among the contractors themselves, who need it most. Co-operation among contractors is essential, for it inspires confidence among those from whom they buy and respect from those to whom they sell."

As the business is now conducted, Mr. Russell pointed out that many who are claimed as friends by legitimate contractors do not give them preference when they have work to let, except when they can force them to accept such work at the lowest bid secured. Further, in many cases the legitimate contractor is asked to prepare layouts and specifications which are submitted to others for bids, and in this way peddle the brains of the best in the business, seldom returning any compensation whatever for the wasted time and energy. He emphasized the fact that electrical contractors are figuring too many jobs and securing too few, and that they should figure on less work and get more that will return a fair profit. He referred especially to the need of co-operation from the central station and the electrical jobber, stating that in most cases electrical contractors are, in fact, solicitors of business for both by selling large quantities of electrical goods and connecting considerable loads on local distribution systems.

In conclusion Mr. Russell made a plea for co-operation in elevating the electrical contracting business in the eyes of the public and among the contractors themselves, and thus inspire confidence in their work and methods. He said: "We want to feel that every contractor who belongs to this association is our friend, and that we can place confidence in him. This is the first requirement and likewise the last and only requirement to reach a working agreement and a mutual satisfatory understanding of our business that will place it where it rightfully belongs in the commercial pursuits of the present day, and at the same time enable those who conduct it to become prosperous and respected citizens."

Following Mr. Russell's address, five-minute impromptu talks on matters pertaining to the electrical contracting business were made by a number of contractors, jobbers, manufacturers and representatives.

The afternoon session was devoted to an address by G. W. Hill, of the National Electrical Contractors' Association, and a discussion of organization details. At the close of this session the election of officers took place, with the following chosen to serve during the coming year: R. M. Walker, Walker Electric Company, Rome, Ga., president; H. E. Lowe, E. Lowe Electric Company, Macon, Ga., vice-president; J. M. Clayton, Atlanta, Ga., secretary; W. L. Bailey, Bailey Electric Company, Atlanta, Ga., treasurer; and T. H. McKinney, T. H. McKinney, Inc., Atlanta, Ga., National Director.

The charter members of the Georgia Section of the National Electrical Contractors' Association are as follows: Bryan Electric Co. (Atlanta); J. M. Clayton (Atlanta); McGaughey Electric Co. (Atlanta); Russell Electric Co. (Atlanta); Bailey Electric Company (Atlanta); Hogue Electric Co. (Atlanta); T. H. McKinney, Inc. (Atlanta); Woodward Electric Co. (Atlanta); C. F. Ludwig & Co. (Dublin); Levy-Morton Electric Co. (Columbus); Walker Electric Co. (Rome); W. J. Mounford Electric Co. (Macon); H. E. Lowe Electric Co. (Macon); Brill Electric Co. (Augusta); Byck Electric Co. (Waycross); Norton Frierson Electric Co. (Savannah).

Some twenty others signified an interest in the meeting through letters written Mr. Hill, the national representative of the Electrical Contractors' Association, and indicating that they desire to become members and will attend the next meeting, which will be held at Macon, Ga., on May 26.

New Business Methods and Results

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

Utility Matters and Recent Decisions of Public Service Commissions.

The main function of a public service commission is to represent the public in its dealings with public service corporations. Yet, in representing the public, the commission also to a very large degree protects public utilities. In most states having commissions, a broad jurisdiction is given and a variety of problems are passed on. The subject of rates is a very common one and one of vital importance to all concerned. In the adjustment of rates, it is generally conceded that the only basis on which a return should be made is that of actual investment. In the case of inflated stock, it is evidently unfair for the public to pay large sums of money as interest on something which has cost the original investor nothing. This brings up the necessity of accurate and careful valuation of the physical property, and here comes a chance for argument. Shall the physical valuation be taken at the original cost, or at the original cost less depreciation, or at the cost of replacement? Commissions have differed in their practice in this regard, but the trend of recent decisions seems to be to take the valuation at the original cost, plus any expenditures for improvements or betterments, making no deductions for depreciation or additions on account of enhanced land values.

Franchises as a rule have not been admitted as affording a valuation on which to base returns. They are, of course, a valuable asset, but do not represent money invested. "Going value" or "good will" has not until recently been taken into account in valuations. However, a recent decision of the New York Court of Appeals in the Kings County Lighting Company case, reverses the decision of the New York Public Service Commission, First District, and allows "going value" in a valuation for rate-making. The decision of the court was to the effect that since the dividends of the company had been very low for several years, and considerable money had been spent in building up the business, that such money represented actual investment of the stockholders just as much as that appearing in the physical property. In other words, if a business is developed out of surplus earnings, after reasonable dividends are paid, there can be no claim for the inclusion of the "going value" in the valuation for rate-making purposes, but if the business is developed out of what would be considered as reasonable dividends, such amount does then become an investment, and as such is entitled to a return.

The State legislature of California has passed an amendment to the state constitution requiring all water and electric lighting companies to procure franchises in their respective cities or boroughs. Inasmuch as the public utilities of the state had made an investment of several hundred million dollars in urban property they made an appeal to the Supreme Court. They maintain, and with some show of reason, that this action was taken as a result of favoritism, and that it is the intention of the municipalities to refuse franchises and establish municipal plants in disregard of the property rights of existing companies. The Supreme Court has declared the amendment invalid.

The New Jersey Commission holds that the free lighting of municipal buildings by lighting companies, when made a condition of the granting of a franchise, is in the nature of service rendered for a valuable consideration, and cannot be construed as discrimination.

The Ohio Public Utility law has been recently amended and the power of the commission enlarged. Power is given to make physical valuation, and to enforce uniform accounting, even in the case of municipal plants. There are also a number of minor features which are improved.

The Nevada commission in making a reduction in the rates of the Eyl Light and Power Company makes a number of interesting statements in its decision. The commission says in effect, "We fully recognize the fact that we owe a solemn duty to the public but that duty carries us no further than to see to it that justice is done the public, without injustice to the corporation. We realize that if we are too drastic, if cuts are made too deep, and public service corporations are left with less than a fair return upon their investment, and less than a fair compensation for the service rendered, which is also an element to be considered, it is more than probable that any court in which the case is tried will hold the order void. In such a case, the commission suffers in prestige, and loses the confidence of the court, which expects it to act in a spirit of absolute fairness. When there are no strictly legal questions involved, a court will hold that an order reducing rates is void only when the point of confiscation is reached. The reason why public service commissions usually stop considerably short of a confiscatory point is that investors are not as a rule willing to engage in business projects of any kind, with the prospect before them of just barely escaping confiscation at the hands of a public service commission."

The Public Service Commission of Ohio has granted authority to the Dayton Light and Power Co. to purchase the entire equipment of the Xenia Gas and Electric Co., of Xenia, Ohio. In rendering the decision, the commission states that such sale will be of public benefit, and will not increase the rates to be paid by the public. and that better and more economical service will be made by such transfer.

The Y. M. C. A. in New York City is giving a series of educational lectures on the question of public utilities. The first meeting was addressed by T. C. Martin and Henry L. Doherty. Such lectures as these will prove to be of the greatest value.

A. G. Rakestraw.

New Business News.

The central station companies at Nashville, Tenn., and Chattanooga, Tenn., have been getting results from their "electric cottages." These are not make-believes but dainty little houses and bungalows of five or six rooms, located in the suburbs, wired complete, and fitted with fixtures, and every appliance from A to Z, displayed in operation just as it would be in actual use. The details of this scheme are found elsewhere in this issue. At Nashville, four different places were taken in turn. Furniture was willingly loaned by local firms for the sake of the advertising. The carpets were bought and used in each house in turn. In this case the visitors totaled nearly 2,700, and the displays resulted in the wiring of 86 houses with 141 new connections and 152 appliances were sold.

In Rockford, Ill., with only 1,000 unwired houses to work on, 200 of these were recently gained in a single campaign. The work was done by an outside contractor at a low figure. Three follow up letters were used, well executed and with a vigorous appeal. This was supplemented by good newspaper advertising.

Columbus, Ohio, has been conducting a "flat rate" wiring campaign in which 8 outlets are wired complete for about $50, with the payments made in installments.

The New York Edison Company has been conducting an early morning demonstration with the idea of showing the passers by who are hurrying to work, the advantages of an electric breakfast. The toaster, egg boiler, coffee percolator, etc., are used. After the demonstration the food is neatly arranged and left on display during the day.

The Panama Pacific Exposition is to be lighted in an entirely new way, at least the reports so indicate, although perhaps after all the idea is just borrowed from the dewdrops. Instead of outlining the buildings, each is flooded with light from concealed nitrogen filled lamps. The architectural lines are brought out by the use of thousands of polished glass "jewels" of all colors. These are suspended in such a manner as to tremble with every vibration of the building, while a breeze will set them all swinging. These jewels, reflecting the rays of the powerful lamps, will outline the building as if with glowing scintillating coals of fire, while still allowing the general illumination to bring out every detail.

Electric vehicles are now used in London for sweeping and sprinkling the streets. They operate without noise or odor, and are especially desirable on this account, as they can be used where necessary at night after traffic has stopped, without annoyance to residents.

In St. Louis the number of vehicles has increased from 11 to 600 pleasure cars and 150 electric trucks in only 7 years.

A Chicago concern is now operating an electric moving van. The capacity is 3.5 tons. The battery is composed of 60 Edison cells and will make about 50 miles on one charge.

A Baker special electric has made a mile in 59 seconds. Another has made 42 miles per hour. A great advantage of the electric vehicle is its rapid acceleration, making it valuable for business requiring frequent stops, turning around, etc.

W. R. Collier, Sales Manager, Georgia Railway & Power Company, Enlarges Sales Organization and Moves Into Model Offices.

In every case it has required years of study, more years of experience, and a long period of evolution to produce an efficient selling force such as now maintained by large public service companies. In the case of the Georgia Railway & Power Company, of Atlanta, Ga., this process of evolution has been in progress from the time the company was first organized in 1902. At this time the city of Atlanta was the largest customer, gauged by the amount of energy annually purchased with the personnel of the sales department consisting principally of one individual who could get along with the city authorities and induce them to sign a contract for the city at regular periods. In contrast to this, the present growth and evolution of the business in Atlanta may be indicated in a way by the fact that now at least a dozen customers use more electricity than the city, based upon Kw.-hrs. consumption per year. Where in 1902 half a dozen individuals could easily solicit and know the electrical wants of every active and prospective customer, today, due to the development of the field and the diversified use of electrical energy, no less than fifty sales specialists are required.

The business of selling electric service as carried on by the Georgia Railway & Power Company is handled by an extensive sales organization divided into several departments, headed by Mr. Collier as general sales manager. The divisions of the sales organization include power, lighting, electric sign and appliance departments, and an advertising department, in which are employed trained specialists in all these lines of sales activity.

Due to recent arrangements, the layout of the sales department is one worthy of comment. As shown in Fig. 1, one large room is occupied by the sales force and clerks, with individual desks. Here all sales records are kept, appropriately filed and indexed by card systems. Provision is also made for assembling for consultation and lecture work, with blackboard space and schedules for various purposes appropriately displayed. At one end of this sales room are two private offices, one occupied by the general sales manager and the other by his assistant.

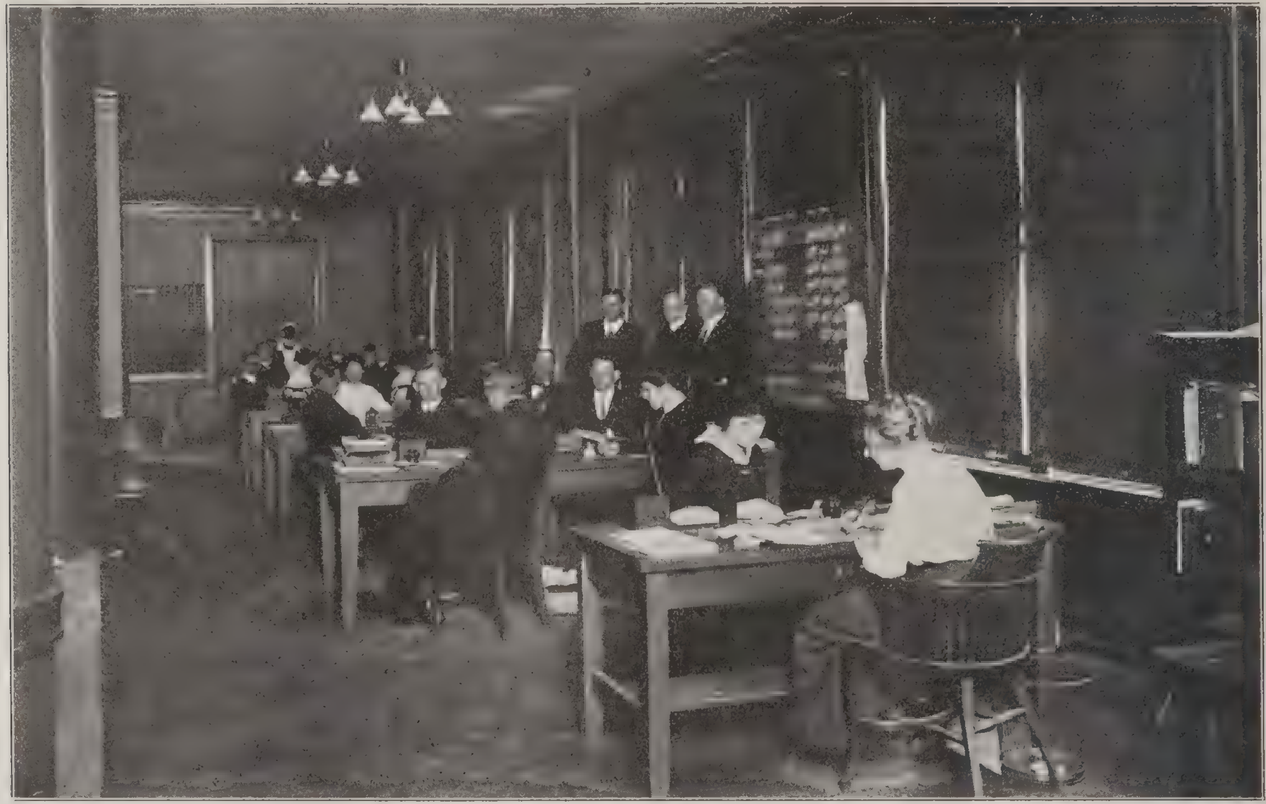
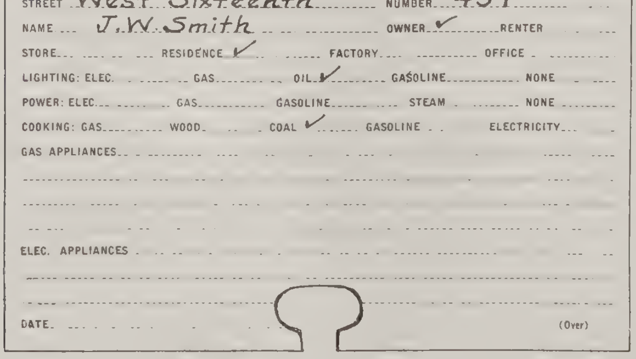


FIG. 1. VIEW OF GENERAL SALES ROOM OF GEORGIA RAILWAY & POWER COMPANY, SHOWING ONLY ABOUT TWO-THIRDS OF ONE SIDE—AT THE RIGHT ARE MORE DESKS, AND AT THE LEFT CABINETS, FILES, ETC.

Each and every member of the sales force is a specialist and is held responsible for a specified territory. He is required to keep in touch with the electrical needs of present customers and work up prospective customers. When a new customer is secured by him and a contract signed for service, such a contract is properly recorded in the sales department and then passed to the chief clerk. From this point the necessary instructions are forwarded to the several departments of the company to supply the particular quantity and quality of service desired by such customer.

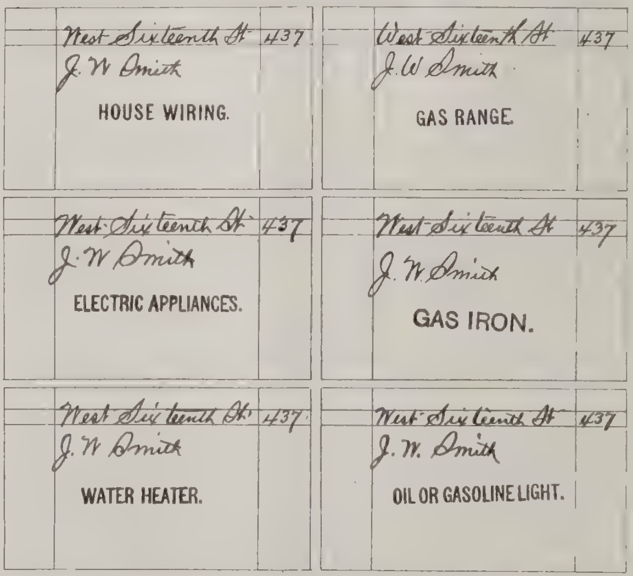
In addition to the work of direct solicitation, as already mentioned, an extensive advertising department is continuously maintained which creates ways and means of educating the public in the advantages of electricity in their commercial and domestic life. In this work the newspapers, the mails, bill-boards and other well-known ways of publicity are employed. A work recently done by the advertising department in the way of an electrical canvass of the city of Atlanta is worthy of mention.



STREET West Sixteenth NUMBER 437
NAME J. W. Smith OWNER ✓ RENTER
STORE RESIDENCE ✓ FACTORY OFFICE
LIGHTING: ELEC. GAS OIL ✓ GASOLINE NONE
POWER: ELEC. GAS GASOLINE STEAM NONE
COOKING: GAS WOOD COAL ✓ GASOLINE ELECTRICITY
GAS APPLIANCES
ELEC. APPLIANCES
DATE (Over)

FIG. 2. INFORMATION CARD USED IN CITY CANVAS.

This canvass was carried on by a force of men similar to a city directory force, the aim being to secure exact data on the use of gas and electricity in every home within the service limits of the company. The result of each call was recorded on a card and appropriately filed for future use when solicitation for certain lines is undertaken. This card system indicates exactly what electrical and gas appliances the customers have and what devices they are prospective purchasers of. The information will be used primarily for solicitation by mail, yet will be used by solicitors and for other purposes when the information is necessary. While this feature has been inaugurated at considerable expense,



West Sixteenth St 437
J. W. Smith
HOUSE WIRING.

West Sixteenth St 437
J. W. Smith
GAS RANGE.

West Sixteenth St 437
J. W. Smith
ELECTRIC APPLIANCES.

West Sixteenth St 437
J. W. Smith
GAS IRON.

West Sixteenth St 437
J. W. Smith
WATER HEATER.

West Sixteenth St 437
J. W. Smith
OIL OR GASOLINE LIGHT.

FIG. 3. CROSS INDEX CARDS FOR MAILING AND CAMPAIGN USE.

it has already proved of decided value in sales work and will be carefully kept up to date in the future. The nature of the cards used for this canvass, and which now make up the indexed information system, together with the information which they show, is displayed in Figs. 2 and 3. The card shown as Fig. 2 is known as the information card and filed according to street number. The cards shown in Fig. 3 are those used in making up cross indexes of the data on the information card for advertising and mailing purposes.

The organization of the Georgia Railway & Power Company's sales force is decidedly complete, and a cooperation exists which is heartily and energetically entered into by each and every member. This spirit is fostered by the sales manager, who keeps in close touch with the men through a weekly meeting of the entire force, at which time the work of the past seven days and any of the problems which are at hand are openly discussed. At these meetings heads of other departments, from the president of the company down, make short talks and give instructive reviews of the business under their immediate charge.

An Electric Cottage Scheme Successfully Used at Chattanooga, Tennessee.

L. J. Wilhoite, Contract Agent of the Chattanooga Railway & Light Company, Chattanooga, Tenn., Demonstrates to 5,000 Visitors the Practical Features of An Electrical Cottage.

One of the most unique cooperative advertising schemes yet to come to our attention from promoters of electrical service, or from any other field for that matter, has been successfully worked out by Mr. L. J. Wilhoite, contract agent for the Chattanooga Railway & Light Company, of Chattanooga, Tenn. In the main, this scheme consisted in the furnishing of a small bungalow for complete housekeeping and equipping same with electrical apparatus suitable for every nature of domestic use. This bungalow was located just outside of Chattanooga and reached by street car lines. The public was invited to visit it and take a look at the possibilities of making life worth living through the use of electricity.

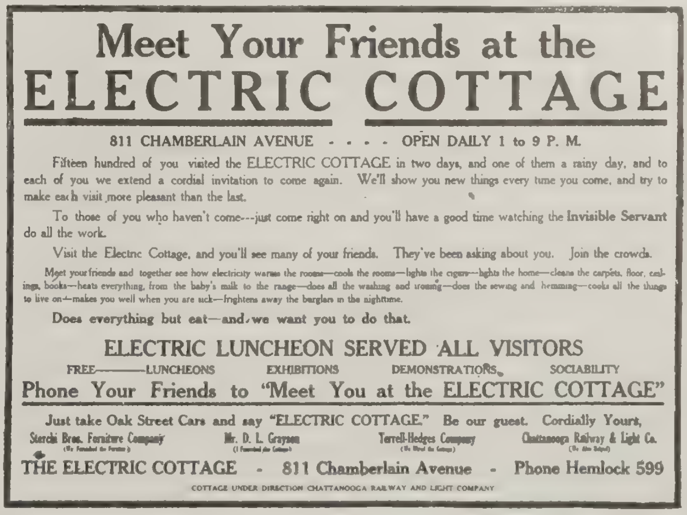
The cooperative advertising part of the scheme came about by getting together with a real estate owner, an electrical contractor, a furniture dealer, a china dealer and a groceryman in such a way that each took advntage of a rare opportunity to display in his own way and in as elaborate a manner as he might choose those things which go to make up a cozy home and are the delight of every housekeeper's heart. The electrical cottage was a well-thought-out scheme, and it had its expected effect, for about 5,000 people visited this electrical home, tasted of electrical cooking, with no gas, no wood, no coal and no dirt around, and observed the truly wonderful effects that electrical home devices can produce. They secured a peek, as it were, of the electrical home of the future, and went away with good intentions that are sure to result in sales to all who made the electrical cottage possible.

The features of electrical interest were as follows: In the library, connected to a baseboard, floor or other proper receptacle, ready for operation, was a foot warmer, table lamp, cigar lighter, candelabrum and fan. In the hall the convenience of three-way switches was demonstrated. In the living room the use of floor and wall receptacles, bracket and piano lamps, as well as a luminous radiator and vacuum cleaner, was shown. In the bedroom a sewing machine with motor and lamp, an electrical vibrator, a nursery milk warmer, a curling iron with heater, an electrical comb, a heating pad, an ozonator and reading lamp were demonstrated. In every case the wiring was so arranged as to show the most suitable control of devices, with a master switch controlling every lamp in the house, and automatic closet lights, as well as receptacles and bracket lamps in their proper and convenient location. In the bathroom small heaters, shaving mugs, hair dryers, and proper location of lights were shown. In the rear hall a washing machine was shown in operation, as well as portable vacuum cleaners and electric flat irons. In the kitchen electric ovens, hot plates, warming closets, fireless cookers, and frying pans were in operation, and here pies, cakes and other eatables were prepared and served in the dining-room, together with coffee, toast and salad or some chafing dish creation. In the dining-room was also shown percolators, tea urns, chafing dishes, hot plates, toasters and other dining-room devices.

The cottage was open for three weeks at a total cost of $408.09, including the following items:

Water	$ 0.75
Telephone	2.25
Coal	7.50
Linens	12.45
Silver	12.50
Hardware	2.25
Cutlery	4.14
Luncheons	40.75
Cigars	9.00
Flowers	8.25
Laundry	2.85
Miscellaneous advertising	113.60
Newspaper advertising	180.40
Miscellaneous	11.40
Total	$408.09

The visitors were brought to the cottage by the use of appropriate advertising, shown herewith, which appeared



Meet Your Friends at the

ELECTRIC COTTAGE

811 CHAMBERLAIN AVENUE - - - - OPEN DAILY 1 to 9 P. M.

Fifteen hundred of you visited the ELECTRIC COTTAGE in two days, and one of them a rainy day, and to each of you we extend a cordial invitation to come again. We'll show you new things every time you come, and try to make each visit more pleasant than the last.

To those of you who haven't come---just come right on and you'll have a good time watching the **Invisible Servant** do all the work.

Visit the Electric Cottage, and you'll see many of your friends. They've been asking about you. Join the crowds.

Meet your friends and together see how electricity warms the rooms—cools the rooms—lights the cigars—lights the home—cleans the carpets, floor, ceilings, books—heats everything, from the baby's milk to the range—does all the washing and ironing—does the sewing and hemming—cooks all the things to live on—makes you well when you are sick—frightens away the burglars in the nighttime.

Does everything but eat—and we want you to do that.

ELECTRIC LUNCHEON SERVED ALL VISITORS

FREE———LUNCHEONS EXHIBITIONS DEMONSTRATIONS SOCIABILITY

Phone Your Friends to "Meet You at the ELECTRIC COTTAGE"

Just take Oak Street Cars and say "ELECTRIC COTTAGE." Be our guest. Cordially Yourt,

Sterchi Bros. Furniture Company Mr. D. L. Grayson Terrell-Hedges Company Chattanooga Railway & Light Co.

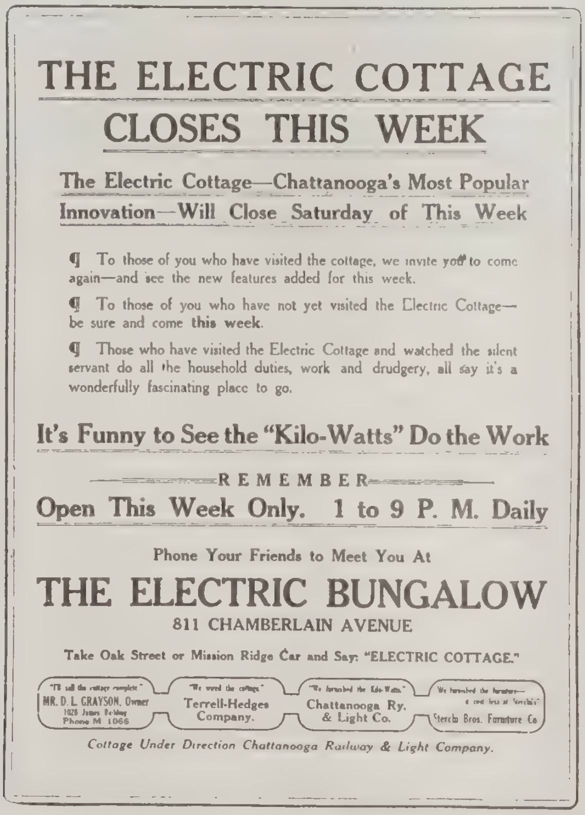
THE ELECTRIC COTTAGE - 811 Chamberlain Avenue - Phone Hemlock 599

COTTAGE UNDER DIRECTION CHATTANOOGA RAILWAY AND LIGHT COMPANY

Fig. 1. Newspaper Advertising Used During the Electric Cottage Campaign.

in the newspapers, moving picture theaters and on posters in street cars. Of this advertising it was found that the newspapers were most effective, based upon the attendance following the appearance of any announcement. The largest attendance followed announcements in write-ups appearing in the society columns of the newspapers, which attendance was during the afternoon and evening.

All guests were asked to register, and by this means the names of 3,401 visitors were secured. On account of the rush at certain times, many did not get a chance to register, so that the total attendance was estimated at about 5,000. Based on these figures, the cost of the demonstration per registered visitor was 12 cents, and 9 cents per estimated visitor. In 50 per cent of the cases 10 cents was spent by each visitor in street car fare, which reduces the cost figure named above to the central station nearly one-half.



THE ELECTRIC COTTAGE
CLOSES THIS WEEK

The Electric Cottage—Chattanooga's Most Popular Innovation—Will Close Saturday of This Week

¶ To those of you who have visited the cottage, we invite you to come again—and see the new features added for this week.

¶ To those of you who have not yet visited the Electric Cottage—be sure and come **this week**.

¶ Those who have visited the Electric Cottage and watched the silent servant do all the household duties, work and drudgery, all say it's a wonderfully fascinating place to go.

It's Funny to See the "Kilo-Watts" Do the Work

REMEMBER
Open This Week Only. 1 to 9 P. M. Daily

Phone Your Friends to Meet You At
THE ELECTRIC BUNGALOW
811 CHAMBERLAIN AVENUE

Take Oak Street or Mission Ridge Car and Say: "ELECTRIC COTTAGE."

"I'll sell the cottage complete." MR. D. L. GRAYSON, Owner 1028 James Building Phone M 1066

"We wired the cottage." Terrell-Hedges Company.

"We furnished the Kilo-Watts." Chattanooga Ry. & Light Co.

We furnished the furniture— [illegible] Sterchi Bros. Furniture Co

Cottage Under Direction Chattanooga Railway & Light Company.

Fig. 2. One of Final Ads Used During Electric Cottage Campaign.

The scheme proved its merits, and all those who made it a success deserve and have truly received due credit. It is one which other central station managers can profitably study and adapt to local conditions. The publicity secured is such as can be secured at a like cost in no other way, and the good impressions created under proper management can be created by few other schemes.

Exchange of Incandescent Lamps by St. Louis Company.

It has been the practice of the Union Electric Light & Power Company of St. Louis to renew lamps only on a lamp-for-lamp basis, crediting such part of renewal allowance for burnt-out lamps against the price of new lamps. An announcement has recently been made by this company that in the future customers will be allowed a credit for all burnt-out lamps returned, in accordance with a schedule of allowances, such credit to apply against the purchase price of new lamps. Credit for burnt-out lamps returned is not allowed, however, against anything else than the purchase of new lamps.

For example: If a consumer returns ten 60-watt Gem lamps, which have an allowance of 15 cents each, or $1.50, the consumer may apply this credit against the purchase price of any other lamps he may desire.

Ross B. Mateer, Commercial Agent, Southern Sierras Power Company, Riverside, California, Comments on "Boosting the Game."

Central stations desirous of promoting increased current consumption frequently resort to campaigning in the densely populated section as well as in rural portions of the country, and hence rely upon the conscientious performance of salesmen. Records are kept of the results obtained, such as appliances sold, calls made and prospects interviewed, that an analysis of the territory may be readily determined. The salesman generally making the most calls is commended, while the man in the rural district, who has many a step to make and whose calls are confined to two or three each working day, plods along and is sometimes regarded, by those who do not know, as a trifle slow. Perhaps it would be well in such cases for those interested in promoting commercial activities and creating a market for current to take a day off, as it were, and tramp over the territory with their employes and endeavor to keep track of it. Perhaps a few miles in a broiling hot sun or a mile in slush up to one's ankles and in a heavy rain would not increase their ardor, but rather awaken the powers that control to the importance of boosting the game.

You ask what boosting the game means. It simply means cooperation along every line, not neglecting to provide suitable transportation, that the man representing the district may be made more efficient. Should you expect him, out of his small salary, to provide a vehicle operated by gasoline or electricty at his expense? You should provide him the means of covering his territory, getting around, as it were, with the least possible waste of time, keeping in touch always with the live prospect as well as encouraging those who are inclined to be backward. Perhaps you will say, "That is what I have hired him for," but how can you expect the energetic, ambitious salesman to turn in results shown by contracted and connected business and at the same time keep in touch with the customers who are inclined to be a little slow and a little backward, when you do not provide him with adequate means of covering his territory?

So I would say to you who sit at your desk, comfortably reading your correspondence, checking reports or pressing the buzzer, that your stenographer may approach and receive your commands, "Get out into the territory and do a little 'hiking' yourself." You will then readily appreciate what a task it is to cover a territory without rapid locomotion. The expense incurred by the purchase and operation of a vehicle under a capable and reliable hand is well warranted when increased sales efficiently is desired. In other words, "boost the game"—provide locomotion and vehicle operation at the expense of your company and note your increase in contracted business, not, perhaps, from those who only dream of big things, but of those to whom business of good load factor is paramount to a large connected load. Boost—never retard.

Questions and Answers from Readers

Readers are invited to make liberal use of this department for discussing questions, obtaining information, opinions or experiences from other readers. Discussions and criticisms on answers to questions are solicited. However, editors are not responsible for correctness of statements of opinion or fact in discussions. All published answers and discussions are paid for.

WHY DOES AN A. C. WATTHOUR METER HUM?

Editor Electrical Engineering:

(451) Please advise through the Question and Answer columns the cause of a hum or buzzing noise in a house watthour meter. Can this hum be prevented, and, if so, how? The meter is operated on a 110 volt, 60 cycle circuit. W. J. C.

LOSS DUE TO SCOTT CONNECTION OF TRANSFORMERS.

Editor Electrical Engineering:

(452) In the January issue the writer asked question No. 429, and inquired as to the loss due to a Scott connection of transformers. The answer was received that the probable loss would be around 3 per cent. What I now desire to know is whether or not the loss of such a connection is greater than in the case of a straight 2-phase or 3-phase transformation. To illustrate my point, please specify for the following conditions: I have a 665 Kva. load under consideration which I can connect to the system in two ways: First, by stepping down 2-phase, 2,200 volts to 3-phase, 440 volts, using two Scott connected 300 Kva. transformers; and, second, by connection to a 3-phase line stepping 3-phase, 2,200 volts down to 3-phase, 440 volts by three 200 Kva. transformers. Under the same conditions of load, would the Scott connection of transformers show a greater energy loss than the straight 3-phase transformation? F. G. F.

CONNECTIONS TO A LOAD BOX.

Editor Electrical Engineering:

(453) The States Company, of Hartford, Conn., has on the market what they call a "load box," the connections of which call for a 3-wire, 2-phase, 110-volt circuit with a neutral. As our standard lighting transformers are all of the 2-coil, 4-lead, 110 to 220 volts, I would like to know if it is possible to comply with such a requirement, using two such transformers on a 2-phase circuit. F. Flick.

CALCULATION OF SECONDARY CURRENT IN WOUND SECONDARY MOTOR.

Editor Electrical Engineering:

(454) Is there any rule by which one can find the secondary current in a wound secondary slip ring motor when horsepower of the motor, current and voltage of the primary is known and motor is not at hand to make a test? Also, can the voltage in the secondary be calculated?

Can an Emerson or Trojan 60-cycle fan motor be reconnected for operation on a 25-cycle circuit? If so, what changes are necessary? F. C. M.

STARTING A LARGE A. C. MOTOR BY WATER RHEOSTAT.

Editor Electrical Engineering:

(455) Is it possible and practicable to start a 440-volt, 3-phase, 100 horsepower A. C. squirrel cage motor with a water rheostat instead of the regular starter? If this is practicable, please give size of rheostat and details of the arrangement necessary for setting up the outfit.

We have a 150 Kw. D. C. generator of 220 volts, having 12 poles. Is it possible to cut out one or two of the armature coils without causing serious unbalancing of the circuits? If this is possible, explain the reason.

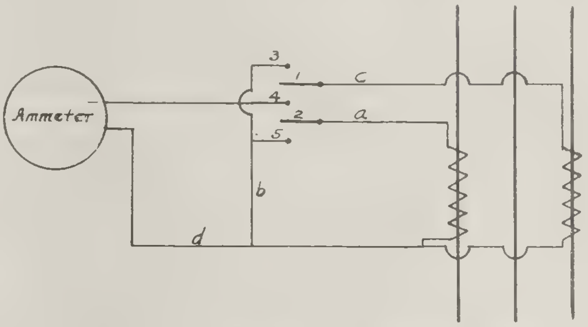
John Ross.

MEASUREMENT OF POWER IN AN UNBALANCED CIRCUIT.

Note.—Question No. 447 appeared in the April issue of *Electrical Engineering* without the diagram to which the inquirer referred. On this account the question is again published, as follows:

Editor Electrical Engineering:

(447) The writer has an ammeter connected to a 3-phase circuit, as shown in the accompanying sketch. The primary voltage is 2,300. Please advise if it is possible to calculate the actual load from the following readings:



Connections for Ammeter to Measure Power in 3-Phase Circuit.

With switches (1) and (2) connected at (4), the ammeter reads 40; with switch (2) connected at (4), and switch (1) connected at (3), the ammeter reads 11; with switch (1) connected at (4) and switch (2) connected at (5), the ammeter reads 38. Can the power factor also be determined from these readings? B. B.

Electric Railway Block Signal System. Ans. Ques. No. 410.

Editor Electrical Engineering:

The manually operated signals on a single track trolley road operate on the principle of a group of lights controlled from two points by three-way switches. In this case, however, the group lights consists of five lamps in series, and the group is divided, two being placed at one end of the block and three at the other. Referring to the Fig. 1, a car at *C*, traveling in the direction of the arrow, takes note that the block *BC* is unoccupied because the lamps are dark. The conductor throws switch *d*, lighting up lamps *k* and *h*, and warning a car approaching the other end that they are about to enter the block. In the meantime the other car traveling in the block *AB* towards the right has thrown the switch *g*, lighting up lamps *l* and *j*, warning the first car that block *AB* is occupied. In case, however, that the car starting from *C* arrives at *B* without receiving a signal, and wishes to proceed to *A*, the conductor throws switches *f* and *e*, putting out the lights at *k* and *h*, and lighting those at *l* and *j*, and so on.

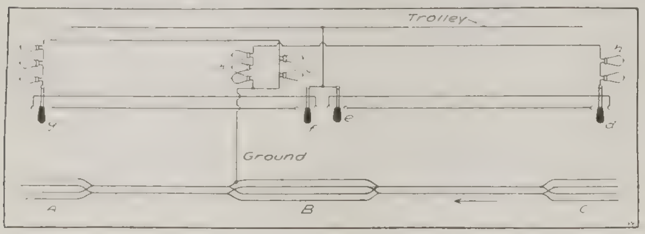
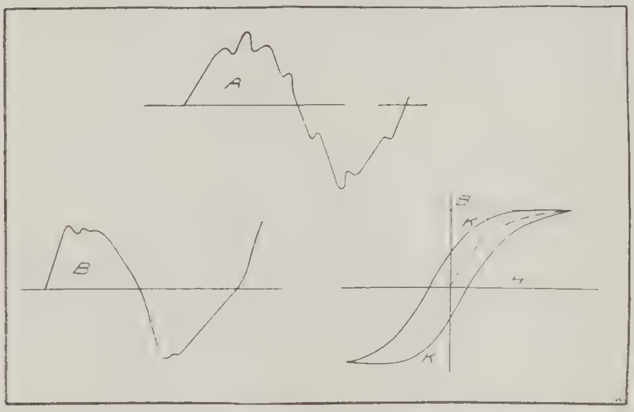


Fig. 1. Signal System for a Single Track Road.

Transformer Design to Suppress Wave Distortions. Ans. Ques. No. 411.

Any transformer will have a tendency to suppress harmonics unless operated at a very low magnetic density. This is evident from a study of the B-H curve, or hysteresis loop. If the iron is well saturated—that is, above the knee of the curve K—harmonics occurring at the peak of the curve will not be reproduced, because there will be very small if any change in the flux density. Harmonics occurring near the points of no-current will be reproduced to some degree. Correction for other irregularieies, such as a steep wave front, as shown at *B*, will likely be carried over into the secondary circuit. The question of high or low magnetizing current will have effect only as it indicates high or low saturation of the iron.



Figs. 3 and 4. Hysteresis Loop and Possible Wave Distortions in Transformers.

Light Absorption of Glassware. Ans. Ques. No. 421.

The density of glassware used for ornamental street lighting may vary from a light alabaster, absorbing 15 per cent of the light, up to opalescent or sand-blasted, absorbing from 20 to 40 per cent. The most common globes used for this purpose are light opalescent or light sand-blasted, the absorption of either of which is not far from 20 per cent.

Distribution of Light From Ornamental White Way Post. Ans. Ques. No. 423.

The writer has never seen a distribution curve of a 5-light standard white way post. Such a curve would be rather hard to get photometrically, since such a standard would be rather hard to handle in the laboratory. Results of tests on such systems are always expressed by isolux curves, showing the actual illumination on the roadway at any point. However, as far as distribution goes, would say that the magnetite arc is more efficient by far in its distribution. Practically all the light is on the lower hemisphere, where it can be utilized, and the greater part of it is delivered at angles but little below the horizontal, thus lighting the street far into the middle of the block. The lamp cluster, on the other hand, very likely has nearly a circular curve, slightly flattened in a horizontal plane on account of interference of the individual lamps; hence also stronger straight upwards, and irregular and broken close to the base on account of shadows of post, crossarms, etc. Merely as light source, the magnetite has the advantage, but as supplementary to existing street lighting the cluster has greater ornamental possibilities.

Rewinding Small Motor. Ans. Ques. No. 425.

I would not advise trying to rewind the battery motor for 110 volts, as it would be an expensive and tedious job. If it is desired to run on a lighting current, I would consider it much better to use the winding, as it is and put a lamp in series. The computation of wire sizes, etc., to be used with a motor of certain voltage and current requires a study of magnetic circuits, and there are too many variable factors to insure accurate computation without some knowledge derived from previous design. Most of the small and cheap motors on the market have been developed by a cut and try process. A. G. Rakestraw.

Satisfactory Grounding Methods. Ans. Ques. No. 407.

Editor Electrical Engineering:

The methods used to secure efficient and permanent grounds for earth connections, for equalizing the static pressure, for protection in case of break-down of transformers, for reducing the pressure between earth and the conductors of a system, are numerous, and each has its good points and many supporters.

There are, however, certain requisites which should not be neglected—namely: (1) Contact surface of grounds should be free at all times from any insulating or high resistance film. (2) The surrounding earth should be in close contact with grounds, and should be of a moisture-retaining consistency. (3) The surface area of grounds

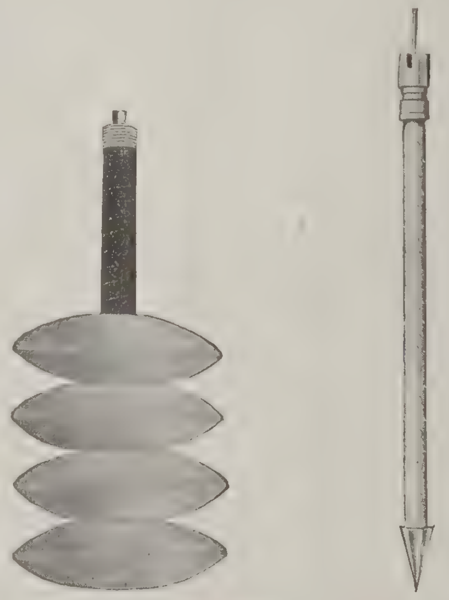


Fig. 1. Devices for Securing Efficient Grounds.

should be irregular to aid in attaining the second requisite. (4) The ground should be of highly non-electrolytic material to assure long life and no decrease in contact area. (5) Connections to grounds should be in plain view wherever possible to facilitate inspection.

Pipe grounds have been popular, but these do not comply with the first and third of the above requisites. Ground plates have sometimes been advocated, but these do not fulfill the second and fourth requirements. Devices for securing efficient grounds are shown in Fig. 1 and known as the Hydroground, and cover all the requisites above indicated. As the illustrations indicate, there are two types—the drive and the disc type. The former holds the hydroscopic element within the perforated sheath and furnishes a very convenient means for installing. Both types are highly non-electrolytic. E. A. Lightner,

Electrical Engineer, Lord Mfg. Co., Brooklyn, N. Y.

Cost of Steam Service for Laundries. Ans. Ques. No. 420.

Editor Electrical Engineering:

The question of justifiable charges for the supply of steam and electricity has long occupied the mind of the central station commercial engineer and the public concern in this respect has grown to some importance. The disputes as to proper and discriminating rates are usually on the docket of the many Public Service Commissions or Utility Boards, and have led to many court litigations. This may therefore be an opportune time to remind correspondents, that in order to properly deal with a problem of this importance, at least some of the general conditions surrounding the proposition should be mentioned. It becomes very difficult to even estimate the cost of steam service when one simply states the electrical generating capacity of a plant. The boiler sizes, and the use and cost of fuel, together with the general or relative proportions of the different items to be considered, should be given.

The methods used in charging for steam services may be classified as either the flat rate or a charge for actual use as recorded by a meter. Where it is not difficult to collect the returns of a system, it is best to use a "condensation" meter, thus weighing and indexing the actual condensed water passing through. But on installations where there is excessive waste and leakage, as for instance, a laundry as now under consideration, it is not an easy matter to gather the condensation, and the use of a graphic recording or indicating "steam" meter must be resorted to. There are many views taken on the relative merits of the meter and flat rate basis of charging for steam, and where either method has been used with discretion, no monetary loss has resulted.

Perhaps the following statement by the American District Steam Company may prove of interest: "The meter method of charging for various public utilities, such as water, gas and electric light, has become universal, and the custom of furnishing these commodities on the flat-rate basis is practiced by but comparatively few companies at the present time. The meter basis is equitable to the company and consumer alike. It is just as reasonable to ask a coal dealer to supply coal at a stated sum per year as to ask a company to supply steam heat on a similar basis. The flat rate is expensive to the company while the meter basis is economical for both the consumer and the company."

The rate charged by different companies for the steam supply, either for heating or commercial purposes, varies with the locality, ranging from 32 cents to over $1.25 per 1,000 pounds of steam. While some companies use a sliding scale based on a certain consumption of steam during a period, others use a scale based on condensation and also vary the rate; in case of heating, basing same either on the amount of square feet of connected radiation or on the cubical contents of the building.

Several cases have come to the writer's notice in which high-pressure steam is supplied for light manufacturing purposes in loft buildings on the flat rate basis of fifty and even forty dollars per horse power per year, which have proven quite profitable. Some instances as to the cost of generating steam are given below.

In all first class, modern hotels, there is usually a laundry attached to the building, and the diagram herewith represents the steam consumption in the laundries of two New York hotels, identified by *A* and *B*, respectively. The capacities of the laundries may be judged by the equipment consisting in both cases of two washers, two centrifugal extractors, one mangle, ironers and other appliances that are customary for this size installation. On a twelve hour basis the total use of steam in the laundry of Hotel *A* aggregates 156 boiler horsepower hours for an expenditure of 542 pounds of coal actually used for this service. Though the hourly use of steam in the laundry of Hotel B is not similar to the variations found in Hotel *A*, it is due simply to the division of the load or distribution of the work during the day, as the total reaches 151 boiler horsepower hours for an equivalent use of 548 pounds of coal. These figures are the results of tests during the actual operation of the building.

The power plant of Hotel *A*, with hydraulic elevators, consists of 1,000 horsepower in boilers and 625 kilowatts in

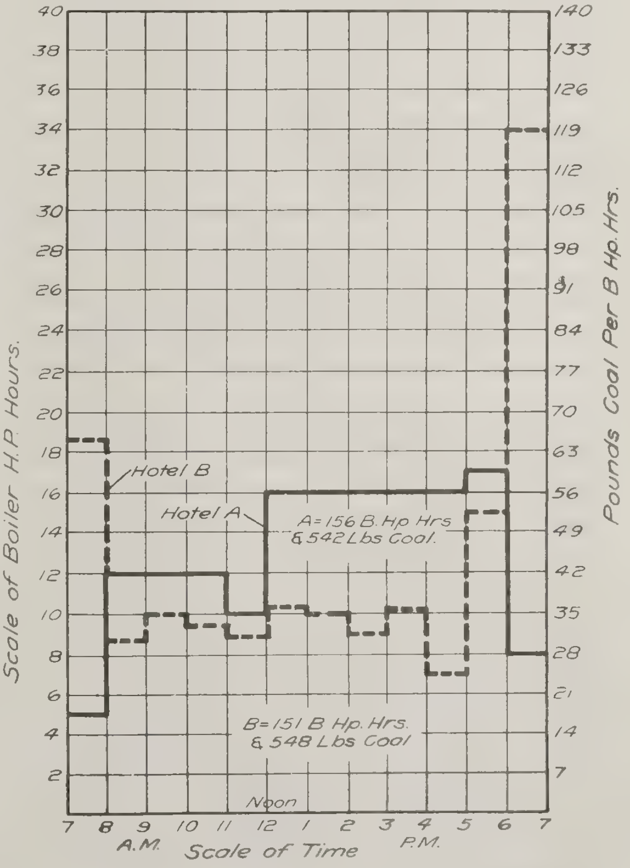


Diagram Showing Use of Steam in Laundries.

generators, with 21 men on the engineering staff. Hotel *B*, with electric elevators, has an equipment of boilers amounting to 720 horsepower and the generators total 500 kilowatts, with 17 men on the operating end. In each case the wages of the chief engineer is in the neighborhood of $3,000 per annum, and coal costs $3.50 per ton delivered. Computations based on the results of tests in these buildings, for 24 hours of operation, show the following values:

Division of Service	Hotel A	Hotel B
Total boiler h.p. hrs. per diem (steam and electric)	100 %	100 %
Steam to laundry in percent of total	1.81%	1.92%
Steam to auxiliaries and other service	43.19%	28.08%
Steam chargeable to electrical service	55 %	70 %
Total steam per month for all services, B. h. p. hrs.	302,400	248,000
Cost of operation; labor, fuel, supplied and repairs	$3,724	$3,064
Cost per boiler h. p. hr., in cents	1.23	1.23

On a ten hour basis, either of these plants can generate steam at an annual cost of 1.23 cents per boiler horsepower hour, or 308 days × 10 hours × 1.23 cents = $37.89 per horsepower per year. In selling steam, to say a neighboring building, the profits or gain would be, if based on the following: (a) charging at $40 per Hp. per year = $2.11 profit, or a little over 5 per cent. (b) charging at $50 per Hp. per year = $12.11 profit, or about 32 per cent.

M. Wm. Ehrlich, (N. Y.)
Consulting Engineer.

Why Field of Large Motor Should Not Be Opened. Ans. Ques. No. 426.

Editor Electrical Engineering:

The following remarks are submitted as an answer to question 426: The inquirer, in the first part of his question, evidently has in mind the breaking of the shunt field on a compound wound motor or the field of a shunt motor, as opening the field of a series motor cuts the current off entirely and causes the motor to stop.

Consider the action of a direct current generator. The current is generated by the armature conductors cutting the lines of magnetic force produced by the field magnets. The same conditions are present in a motor—that is, the armature conductors cut the lines of force from the field and generate an emf. exactly as in the case of the generator, except that this emf., instead of causing a current to flow out on the line, is in opposition to the line current, and is known as the counter emf. of the motor. This explains why a motor with a comparatively very low resistance may be run on a circuit whose voltage would cause a current large enough to burn up the motor were it not for the counter emf. opposing the line voltage.

Of course, with no field on the motor, there would be no lines of magnetic force to cut, consequently no counter emf., and the current that would flow would be limited only by the resistance of the armature, which is comparatively very low, and would destroy the armature coils.

Consider the motor discussed in the answer to the first section of this question. If the field were weakened in any way, the lines of magnetic force would diminish and thus lower the counter emf. so as to allow a greater current to flow in the armature. This greater current would increase the torque, hence increase the speed. This principle is used to some extent to vary the speed of motors in commercial operations.

Now consider the series motor. When the load is removed by the belt flying off or in any other way, the motor would naturally speed up a little on acount of having a lighter load. This increase of speed increases the counter emf., lowering the current which passes through the series field and diminishes the lines of magnetic force, allowing more current to flow. This increases the torque and speed still further, lowering the current still more by increasing the counter emf., and so on, accumulatively, until the motor may reach a speed high enough to burst the armature.

Henry A. Davis (N. Y.).

Why Field of Large D. C. Motor Should Not Be Opened. Ans. Ques. No. 426.

Editor Electrical Engineering:

When a D. C. motor is in operation, the conductors wound on the armature pass through the magnetic field formed by the lines of force which pass from the field poles. This is the same action as takes place in a dynamo, and the result is the generation of an emf. in these conductors. In the case of the motor, this emf. opposes that of the line, and is called counter emf. This counter emf. is a maximum when the motor is operating at running speed or over. When the conductors are not being revolved, no counter emf. is being generated, and, therefore, when starting a motor, a starting rheostat of some kind must be employed for all except very small motors. The counter emf. holds down the current taken by the motor, and, therefore, in starting, when there is little or no counter emf., resistance must be inserted to hold down the inrush of current. The rheostat is so designed that the resistance may be cut out in steps, and as the speed increases the counter emf. reaches a value which is sufficient to make resistance unnecessary.

When a motor is connected to the lines, the current (without a starting rheostat) may be approximately calculated by ohm's law: $I = E/R$, but after it is up to speed the formula must take into account the counter voltage or: $I = (E - E^1) \div R$, in which I is current; E, line voltage; E^1, counter emf.; and R. resistance of armature conductors. The current of a 110 volt motor with 1 ohm armature resistance at standstill when no counter emf. is developed would be $I = 110/1 = 110$ amperes, which would burn out the conductors and cause flashing at the brushes. At full speed the current would be approximately $(110 - 100) \div 1 = 10$ amperes.

This shows that without counter emf. a large destructive current flows. There is no counter emf. if the current is cut off from the field circuit, because in this event there is no magnetic field. Cutting off the field current, therefore, results in the loss of magnetic field, and this means that no counter emf. will be generated. A large inrush of current will follow the opening of the field circuit with flashing over at the brushes, etc.

The tendency of a series motor to speed up in case of removal of the load is also concerned with counter emf. The design of a series motor is such that the field circuit is in series with the armature, and the current that passes through one passes through the other. When the motor is running at its normal speed it will be developing a counter emf. which, bucking the line voltage, will hold the current to a given safe value. Increasing the speed of the armature will cause the conductors to cut the magnetic field at a greater rate and increase the voltage (in the case of a motor, counter voltage). As indicated by the formula, $I = (E - E') \div R$, if the counter emf. E' is increased, the current I will decrease.

Reducing the current in the case of a series motor also reduces or weakens the magnetic field, because armature and field circuts are in series. So to make up for weakening of the field, the armature conductors must again increase their rate of speed to generate the same counter emf., because this depends on the rate of speed and the magnetic field. If the latter is weakened, the speed must be proportionately increased. The wakening of the field due to decrease in current following the increase in armature speed is a cumulative effect. The increase in speed results in a weaker field, because it cuts down the current in the armature and field, and weakening of field results in an increase in speed to make up for this weakening. The result is that the motor will race. For this reason a series motor is in practically all cases direct connected to its load, so that there is no possibility of its running free.

George J. Kirchgasser (Wis.)

Generating Equipment for Small Central Stations. Ans. Ques. No. 432.

Editor Electrical Engineering:

Without knowing the conditions and layout of the town referred to by B. J. K. in question 432, it is impossible to say whether a D. C. or A. C. system will be best suited. Since the town has a population of some 3,000 people, as a general proposition a D. C. system would not have the advantages of the A. C. system since the cost of copper for an extensive distribution system as the plant grows would be in favor of the latter system. In many cases the A. C. system enables the station to reach out and serve customers that provide a favorable load while with the D. C. system the cost of reaching this load would be prohibitive. With the D. C. system a size of wire for the feeder lines could not be smaller than No. 6 while with the A. C. system an even smaller size might be possible at a reasonable high voltage for the primary lines and a No. 8 for the secondary with transformers located as near the load as possible.

As regards installing the direct current system and later changing over to the alternating current system, this might be possible by using the old D. C. feeders as secondary lines but even then the size of wire would probably be larger than required.

For a town of 3,000 a load of at least 1,500 lights can be expected within one year so that it will be well to take a liberal growth into consideration when installing the initial equipment, for changing and rebuilding a plant is an expensive proposition. The writer would advise the installation of a 50 Hp gasoline or oil engine and a 37 Kva., 2300 volt, 60 cycle, 3-phase, revolving field alternator so that a motor load could be handled when the time came for the securing of same. The writer has just completed a plant of this sort and finds that the equipment above mentioned operates 10 hours on 50 gallons of oil which costs five cents per gallon. Our load consists on an average of 200 lights of 25, 60 and 100 watts, two deep well water pumps with three inch cylinders lifting water 400 feet and discharging into a tank 100 feet above the pumps. This is I believe very good operation for a plant of this size.

Another feature in the adoption of a 3-phase generator is that single phase operation can be secured by leaving out the middle winding and connecting up the single phase load to the outside lines. When this is done, the single phase capacity of the 37 Kva. machine is about 20 Kva. The sizes of transformers to use should be 2, 3 and 5 Kw, care being taken to keep the phases balanced when the load on any transformer is increased.

The equipment for the switchboard should consist of a 2300 volt oil switch, 3 ammeters, one voltmeter and plug switch, one field regulator for exciter and one for generator, one potential transformer for voltmeter, 3 shunt transformers for ammeters, one field switch and discharge grid and perhaps an automatic circuit breaker. The cost of such a plant should be around 8 to 10 thousand dollars.

Edward Dumas. (Texas.)

Specifications for Generating Equipment for Small Central Stations. Ans. Ques. No. 432.

Editor Electrical Engineering:

One of the first considerations entering into the design of a central station should be continuity of service. Uninterrupted delivery of power to consumers is demanded for purposes of revenue and to command public satisfaction and good will. Overhead charges are continuous, which necessitates continuous revenues to make the company successful financially. Satisfied customers mean a continued increase of new customers.

For an electric plant to give continuous service it must be a duplicate plant. In the case cited it would doubtless be better to first install a 15 Kw. direct-connected unit. Do not consider a belted arrangement, although this will mean a lower first cost. As the demand for power increases, add another 15 Kw. direct-connected unit to be operated in parallel with the first unit. The plant is now a duplicate plant, and cannot easily be put entirely out of commission.

If the demand for power still further increases, add a 20 Kw. unit. This not only provides for more certain continuity of output, but adds a most essential feature—that of maximum efficiency of operation of plant. Electrical machines operate at their highest efficiency at about their rated load output. As the daily demand for power increases, additional units may be connected in, according to the demand. For example, suppose the three units are already installed, and the maximum demand for power occurs between 5 and 7 p. m. For the first demands, say for from 4 to 5 o'clock, a 15 Kw. unit may be operated. At about 5 o'clock the 20 Kw. unit may be connected in. On special occasion it may be necessary to connect the second 15 Kw. unit in circuit to meet a maximum demand. When the maximum demand does not occur, one 15 Kw. unit should be operated one night and the other 15 Kw. unit the next night. At a comparatively small expense for a 15 Kw. unit, the whole plant is really made a duplicate plant.

The estimated load is 14½ Kw., but this could be reduced by using not over 60 watt tungsten lamps for street lighting. For the best street lighting effects, small units placed nearer together give much better satisfaction than larger units spaced farther apart. Place a 60 watt lamp on every other pole, the poles being spaced 150 feet apart.

If the most of the load comes within a circle having a radius of a mile, a D. C. system, which is cheaper to install, is much simpler and operates at a higher efficiency than any A. C. system, and is advisable. Any 110 volt system can be changed to a higher pressure system and will then operate at an increased efficiency, but all of the lamps will have to be changed. It will not be at all advisable to consider changing to a three-phase A. C. system. This would involve a very large outlay for new machinery and additional labor. The lamp load would need to be properly distributed between the three phases, or else the plant must be operated at decreased efficiency. Any arrangement gives an undesirable power-factor if motors are used on the same lines with the lamps. Wait for the power demand to develop and then install a separate line to supply power for motors.

The switchboard should be provided with a circuit-breaker for each unit and for each circuit leaving the station; a voltmeter for each unit, or a proper switching device, so that one voltmeter may be connected as desired with each unit or with the main line; an ammeter for each unit, and a field rheostat for each unit. Fuses should also be installed in connection with the circuit-breakers. If the circuit-breakers operate properly, the fuses will not blow out; but if for any reason the breakers fail to operate, the fuses will protect the generator. Suitable protection from lightning should be provided.

It is difficult to give a complete estimate of costs because of insufficient data as to distances, location of load, nature of the country, and cost of labor. Such a plant as described to supply 15 Kw. to a section of about three square miles under ordinary conditions should cost between three and four thousand dollars. If a water power is available, within three or four miles, it should be carefully considered.

Reducing Supply Voltage for a Particular Load. Ans. Ques. No. 433.

It may be possible to prevent the burning out of the lamps, when arranged as suggested, by connecting equalizer wires as shown in Fig. 1.

If the pressure applied to the lamps is reduced from 114 to 105 volts by use of a resistance, its value in ohms may be found, very nearly, by the following method:

Since each lamp operates at 6 watts and 6 volts, it requires 6/6 = 1 ampere. A set of 19 lamps in series will take 1 ampere. If there are 10 sets in parallel, the total current taken by the group of lamps will be 10 amperes. The difference between 114 and 105 being 9 volts, the required resistance will be R = 9/10 ohm, assuming the current in the lamps is the same after the reduction of the applied pressure. The current in the lamps will be less after the reduction of the applied pressure. The kind of lamp not being known, the current cannot be computed, the resistance temperature coefficient being unknown.

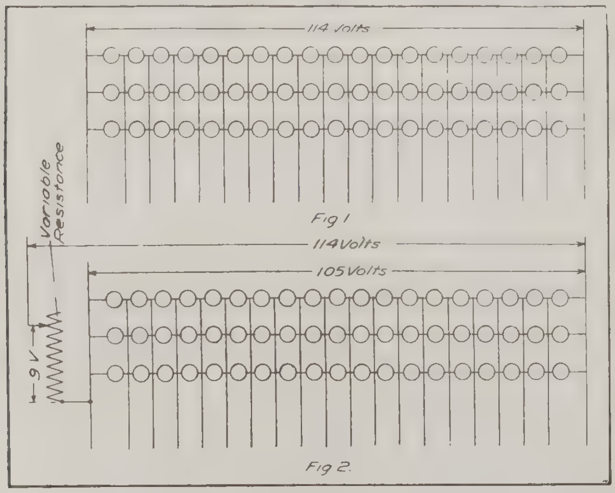


Fig. 2 and 3. Connections for Lamps of a Sign.

The resistance of each lamp when operating at 6 volts and 6 watts will be expressed by $R = W \div I^2 = 6 \div 1 = 6$ ohms. A row of ten of these lamps connected together in parallel will have a resistance of 6/10 ohm. It will, therefore, be more efficient to add 10 more lamps to the present arrangement, making 20 lamps in series in each set instead of 19. It is possible that this is not desirable because of the make-up of a given sign, and a variable resistance of 9/10 ohm, maximum, may be connected with the arrangement as indicated in Fig. 2, and so arranged as to enable a variation in resistance to be obtained. A strip of "Nichrome" ribbon 1/2 inch wide, 0.0113 inch thick, and 10 feet long will answer. If less than 9/10 ohm is desired, only a portion of the ribbon need be connected in circuit.

Prof. F. E. Austin (N. H.).

Reducing Supply Voltage for a Particular Load. Ans. Ques. No. 433.

Editor Electrical Engineering:

The 190 lamps connected as stated above have a combined resistance of about 11.4 ohms, and the total current taken is 10 amperes. If the lamp voltage is to be reduced to 105, the current taken by the lamps will be 9.2 amperes, assuming that the resistance of the lamps remains constant. This assumption will not lead to any appreciable error. Since the voltage is to be reduced 9 volts, a resistance of one ohm would be required. This resistance would have to radiate energy at the rate of 80 watts, and, if made of copper wire, would require about 400 feet of No. 14. While this scheme is wasteful of power, the total Kw.-hrs. consumption would be less than without the resistance, so that if the illumination is satisfactory at the lower voltage, there could be no serious objection to its use.

Nature of Field of Single Phase Motor. Ans. Ques. No. 435.

The single phase induction motor has a revolving field when it is up to speed, regardless of whether the starting winding is cut out or not. This field is elliptical in shape at speeds below synchronism, and is not circular, as is the case with the polyphase motor field. A motor constructed as outlined in the second part of the question would have no starting torque, although it would run fairly well when brought up to speed. The same would be true of the Lincoln two pole generator, but the performance would not be satisfactory in either case.

220 Volt Instruments on 110 Volt Circuits. Ans. Ques. No. 437.

The ammeter mentioned would indicate accurately the current through it, regardless of whether the circuit is 110, 220 or any other commercial voltage. The voltage of the circuit on which an ammeter is to be used is stamped on the name plate of the meter only in case it is to be used on extra high voltage circuits, and this rating is only intended to show the maximum voltage of the circuit on which it is permissible to use the meter. A good 220 volt meter should indicate accurately the voltage of the circuit on which it is used so long as the voltage does not exceed the rated voltage of the meter.

If the D.C. type of instruments are referred to in the last part of the question, they are usually of the permanent magnet or D'Arsonval type. The moving coil of this instrument consists of several turns of small wire mounted on jeweled bearings and placed in a permanent magnetic field. The same field and same moving coil may be used in building either an ammeter or voltmeter. In the voltmeter the moving coil is connected in series with a high resistance, and in the ammeter it is connected across a low resistance shunt which is mounted inside of the instrument. The principle of operation is the same in either case, and depends on the fact that a wire carrying a current is pushed sidewise by a magnetic field. The needle is held in the field by means of a spiral spring, and when current flows through the moving coil, the side push may be expressed by the equation $T = KI\phi$, in which T is the torque tending to turn the moving coil out of the field, K is a constant, I is the current through the moving coil, and ϕ is the total number of lines of force from the north to the south pole of the permanent magnet. Since ϕ is constant in the above equation, it is obvious that the torque of the meter will vary, as the current through it, and consequently the scale, will be uniform so long as the elastic limit of the spring is not exceeded. Prof. F. J. Rankin (Colo.).

220 Volt Instruments on 110 Volt Circuits. Ans. Ques. No. 437.

Editor Electrical Engineering:

The indications of an ammeter are in no wise affected by the voltage. An ammeter used on a 110 volt circuit will indicate current with equal accuracy on a 220 volt circuit, providing the maximum current is within the range of the instrument. The same holds true with a voltmeter. A voltmeter which correctly indicates the pressure on a 220 volt circuit will indicate the correct difference of potential on a 110 volt circuit.

Weston meters are of the moving coil type, and their operation depends on the principle that when a conductor of electricity is placed in a magnetic field, it tends to move. The moving conductor consists of a coil of very fine wire wound on a light aluminum frame, pivoted in the field of a permament magnet. When a direct current is passed through this coil it moves into a position in which it encloses the lines of force emanating from the magnet. A soft iron cylinder is inserted into the moving coil to provide a better path for the lines of force from pole to pole and produce a uniform field, which permits the meter scale being uniformly graduated. The pointer is secured to the moving coil. The object of the aluminum frame is to render the instrument deadbeat, due to the fact that eddy currents are induced in the frame when it moves through the magnetic field, and this tends to check excessive movement of the needle.

A spring at each end of the coil opposes its movement, and they are coiled in opposite directions, so that when the coil moves, one spring winds up while the other unwinds. This arrangement compensates for any error in the working of the meter which might occur due to non-uniformity in the spring material. The springs also serve to carry the current to the coil. Instruments of this type can only be used on direct current.

The moving coils in these instruments carry very small currents, so that when an instrument of this kind is to be used as a voltmeter, a high resistance must be placed in series with it. These resistances are known as multiples, and are usually mounted within the instrument itself. When used as ammeters, due to the above mentioned fact concerning their low current-carrying limitations, use is made of a shunt, which is made of manganin German silver or any material having a high specific resistance and low temperature coefficient. The shunt is connected in series with the line in which current measurements are to be made. With this arrangement the meter simply measures the drop across a definite length of the shunt, at which points suitable terminals and leads are provided for connection to the meter. As the resistance of the shunt and meter bear a fixed ratio to each other, it follows that the current through the meter will be a fixed proportion of that passing through the shunt, and the meter scale, instead of being marked to show the current actually passing through it, can be calibrated to read the current passing through the mains. Shunts and the leads provided with them for connection to the meter are always calibrated with the meter, and should never be altered in any way or any attempt made to use them with any other meter, except with the one they were calibrated for. The leads are always made long enough to permit of the meter being located a reasonable distance away from the shunt where necessary. If the leads are too long, they should not be cut off, but coiled up out of the way.

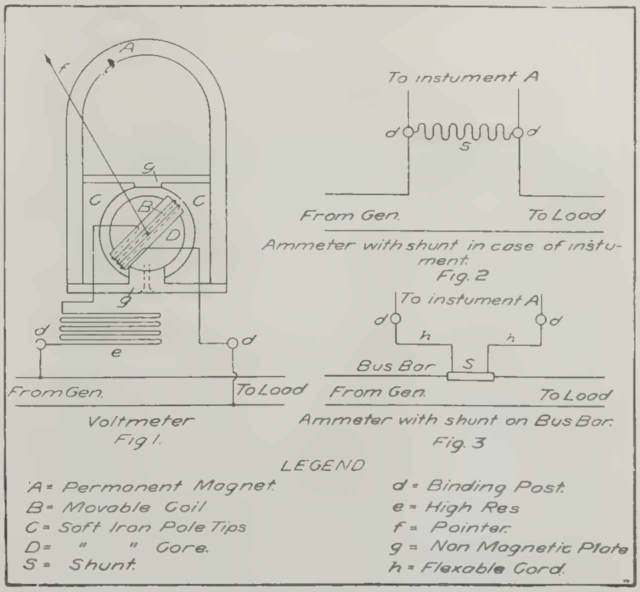
P. Justus (Ohio).

220 Volt Instruments on 110 Volt Circuits. Ans. Ques. No. 437.

Editor Electrical Engineering:

Both the 220 volt D.C. ammeter and voltmeter will give correct readings when placed in a 110 volt circuit. As the ammeter reading depends only on the number of amperes flowing in its circuit, it is entirely independent of the voltage. In a 220 volt voltmeter, when placed in a 110 volt circuit, the normal position of the pointer will be about at the middle of the scale.

The operation of a Weston ammeter or voltmeter is as follows: A movable coil, to which a pointer is attached, is placed in the field of a permanent magnet. Current flowing through the movable coil turns it and the pointer, the same as the armature of a D.C. motor turns when current is sent through it. This turning of the coil is opposed by



CIRCUITS OF WESTON INDICATING AMMETERS AND VOLTMETERS.

a hair spring, which also brings it back to zero when current is cut off.

In a voltmeter a high resistance is placed in series with the movable coil in order to allow but a very small current to flow through the movable coil, while in an ammeter, in order to have this small current flowing through the instrument, the ammeter current is shunted. In ammeters for small currents this shunt may be placed in the case of the instrument, while for large currents the shunt is placed in the bus bar, and two cords from the instrument are attached to terminals of this shunt. Care must be taken that these cords are not broken, as even an inch cut off these cords will give a false reading, because the current in the movable coil is due to the voltage drop of the shunt, which is very low (usually only a fraction of a volt), and the least change in the instrument circuit will cause a proportionately large change in the reading. A. J. Kalinowski (Colo.).

Air Tanks for Braking on Interurban Cars. Ans. Ques. No. 440.

Editor Electrical Engineering:

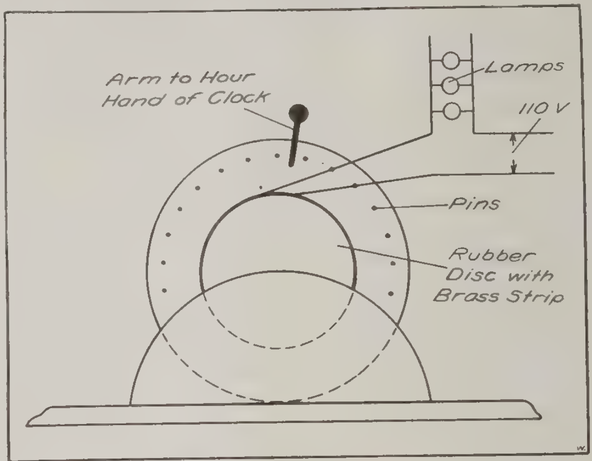
In answer to question 440, the writer does not know of any companies in the South using the tank system for air brakes, nor of any manufacturing company who advocates such a system of air braking. The only place that I know of such a system ever being used was on the Albany-Schenectady interurban line of the United Railways Company. The method of charging the tank was from a storage tank arranged at one of the substations about half-way between Albany and Schenectady. There was a compressor installed in this substation, and I recall that it generally took about five minutes to charge the car tank. In rainy or snowy weather this was naturally rather disagreeable for the crew of the car, and it was rather exasperating to passengers to be held up for five to seven minutes waiting for the air tank to be charged.

Personally, I cannot see anything to recommend the air tank system over the individual compressors. There might be circumstances under which the air tank system might be more advantageous from a price standpoint, and none of the disadvantages would be felt, such, for instance, as a short line having five to ten-minute lay-overs at each end of the line, where storage stations could be used without loss of time otherwise. In the early development of the individual air compressor it is quite possible that stationary large compressors were more reliable than the individual compressors on the cars, but in the present state of development of individual compressors they are absolutely reliable, and I am inclined to think that they are an even better piece of apparatus, as far as reliability and maintenance are concerned, than most of the large stationary compressors. H. E. Bussey (Ga.).

Making Use of the Scraps.

Editor Electrical Engineering:

The city clock in the writer's town is illuminated by 12-25 watt tungsten lamps. When we recently provided a 24-hour service, these lamps burned the entire time, and, besides consuming current, caused an expense through lamp renewals. The following scheme was, therefore, devised to cut the lamps out of service during daytime: A wood disc, 6 inches in diameter and ¼ inch thick, was turned up and provided with 24 brass nails, located at equal intervals around one side near the edge, as shown in Fig. 1. On one side of this disc a hard rubber disc from a broken water meter was attached, on the edge of which a piece of brass was attached to make contact with two spring brushes and close the lighting circuit during the time lamps were required at night for clock illumination.



HOME-MADE TIME SWITCH.

The two discs were made to revolve once in 24 hours by mounting in such a way that a ground clamp attached to the clock hour hand shaft was made to engage in the pins of the disc and cause same to revolve 1/24 of a revolution each hour. The time the lights are on or off can be changed by lengthening or shortening the brass strip on the rubber disc. The whole apparatus was made from discarded material and does the work of an expensive time switch.

G. W. Hubbard (Ga.).

Cleveland Electrical Exposition.

An electrical exposition to be held at Cleveland, Ohio, May 20 to 30, is being arranged by the Electrical League of that city. Since Cleveland is the home of many electrical interests, such an exposition promises to be of especcial interest. This city is the headquarters for the greatest lamp works in this country, the home of the biggest carbon manufacturing plant, and it boasts of three leading manufacturers of electric vehicles. It holds high rank in the manufacture of electric cranes and hoisting machinery, and is a leader in the making of batteries. It claims many of the largest electrical machinery plants, and its public service company is said to be a model of progress and efficiency.

National Association of Electric Sign Manufacturers Organized.

At the second meeting of the Electric Sign Manufacturers, held at Chicago, March 30 and 31, a permanent association was formally created, to be known as the National Association of Electric Sigh Manufacturers. At this time the constitution and by-laws, prepared by a committee appointed at the first meeting last fall, was presented and adopted.

The following officers were elected: President, George R. Hall, National Electric Sign Company, Jersey City, N. J.; first vice-president, F. A. Kehl, Brilliant Sign Company, St. Louis, Mo.; second vice-president, Norman B. Hickox, Greenwood Advertising Company, Knoxville, Tenn.; third vice-president, T. J. Macey, Macey Sign Company, Toronto, Canada; and treasurer, C. M. Davis, American Sign Company, Kalamazoo, Mich. The secretary will be appointed later.

New Apparatus and Appliances

Detroit Ironclad Entrance Switch.

For some time the Detroit Fuse and Mfg. Company of Detroit, Mich., has been developing types of switches that eliminate danger to life and property when used in general electrical service. An important step in this direction was taken in the introduction of a line of switches known as the "ironclad fuse" switch which carries out the conduit principle of electrical construction by enclosing the switch in a metal case operated from the outside. The first switch of this sort was produced by the company in 1909.

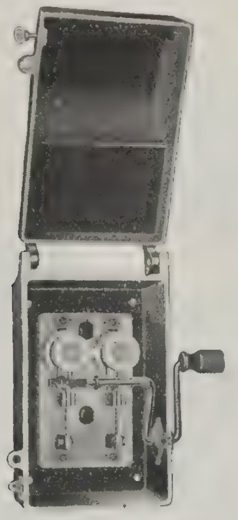


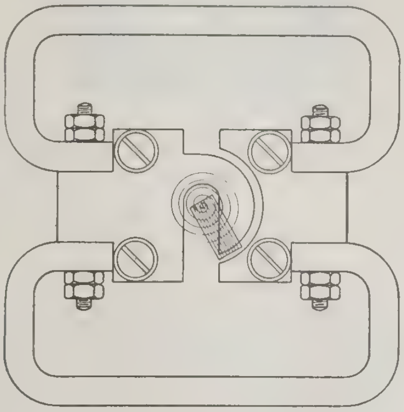
Fig. 1. Showing Two-Pole Switch for Edison Plug Fuses.

The illustration here shows a switch and cutout that may be operated outside the enclosing case designed for entrance service connections but may be used where an enclosed switch is desirable. The switch may be locked "off" by the use of a padlock, making it impossible to operate the switch until the lock has been removed. Thus change of tenants in apartment houses and other rented property where these switches are installed, does not require removal of meter and connections by central stations. The switch can be arranged for a detachable handle, making it impossible for unauthorized persons to get into the switch mechanism.

Westinghouse Laboratory Portable Meter.

A line of portable laboratory meters has been designed by the Westinghouse Electric & Manufacturing Company, which operate on the D'Arsonval principle and, and claimed to be free of residual errors. These meters differ from other meters using the D'Arsonval principle in having a single air gap through which the moving coil, pivoted at one edge, swings. The single gap, it is claimed, permits of maximum torque per unit of weight.

The accuracy of these meters is further assured by treating, magnetizing and artificially ageing the magnets with their pole pieces complete according to the process originally developed by Madame Curie, the well-known discoverers of radium, this process being recognized as incomparably superior to all other processes. To further guarantee against change in strength, the magnets, after treating, are stored for six months. Any magnets that show a decrease in strength after this time are rejected. The moving coil and pointer are then assembled in the magnetic structure, and the manufacture is completed without disturbing the magnetic circuit, an arrangement impossible in the bi-polar D'Arsonval instruments. The light metal frame on which the moving coil is wound moves through the air-gap of the magnets and makes the reading inherently dead-beat. This important feature enables readings to be taken quickly and prevents violent fluctuations from injuring the pointer or the moving element.



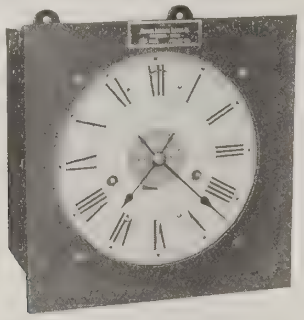
Construction of Westinghouse Portable Laboratory Meter.

The scale, which is 11½ inches long, subtends an arc of 100 degrees, giving large, open divisions, which are of uniform length throughout. The scale has diagonal markings which facilitate accurate readings of fractions of divisions. A mirror extending the entire length of the scale enables the prevention of parallax in reading. For use with the millivolt meters, combination laboratory portable shunts are supplied. These combination shunts include three shunts of any desired capacity up to 200 amperes mounted in a single box with suitable terminals. These meters are supplied as voltmeters or as millivoltmeters. The millivoltmeters can be used as ammeters in connection with high accuracy.

New Westinghouse Laboratory Meter.

Reliance Time Switches.

A type of time switch has been designed by Benjamin F. Flegel, of the Reliance Automatic Lighting Company, Racine, Wis., which will open and close an electric circuit according to a schedule. The closing and interrupting device is operated by a clock that requires winding every seven days, the whole mechanism being located at the back of the clock dial, making a compact device.



Reliance Time Switch for Indoor Use.

This time switch has been designed for operation on electric sign, window and store circuits, on apartment house hall lights and other similar circuits. Central stations find these switches of service on circuits feeding flat rate customers contracting for a certain number of hours each night, and for this service a weather-proof design is made that can be mounted on a pole or elsewhere outdoors. Another use among central stations and their customers is in the charging of electric automobiles. These are only a few of the uses for this time switch, some 26 different types being made to serve the different services where accurate interruption and connection is important. The switch shown here with is for indoor use, the outdoor type being furnished with a closed face.

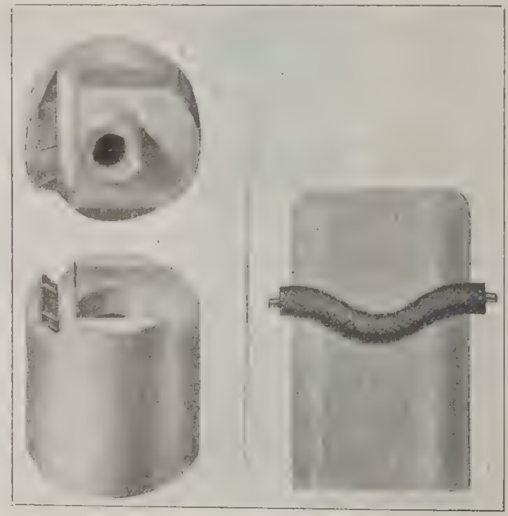
White Way at Michigan City, Ind.

An ornamental street lighting system has recently been installed at Michigan City, Ind., which has done much to beautify the business section. All unsightly wooden and iron trolley poles have been removed and a modern trolley construction installed by which the spans have been fastened to the fronts of the buildings. The only posts now on the street are the ornamental lighting posts, and the appearance of the street is as shown in Fig. 1. This system includes 117 five-light Commonwealth posts, made by the George Cutter Company, of South Bend., Ind., and the entire system installed cost $10,500.

The type of post used is shown in Fig. 2. The base of this post is 18 inches square and 2 feet high. The column is an 8-inch octagon at the bottom, tapering gracefully to a 4-inch octagon at the top. The height from ground to bottom of pendant globes is 11 feet; to top of top globe, 14 feet. The pendant globes are 12 inches in diameter and the top globe 14 inches in diameter. The distance from center to center of opposite globes is 36 inches. The post weighs 675 pounds and is made of high-grade cast iron.

A New Split Knob.

A new split knob has been produced by the Star Porcelain Company, Trenton, N. J., which can be used with wire without tying. As shown in the accompanying illustration, this knob is self-centering, and draws and holds the wire securely when in place by means of a curve between the top and bottom without cutting or in any way damaging the insulation.



A New Split Knob.

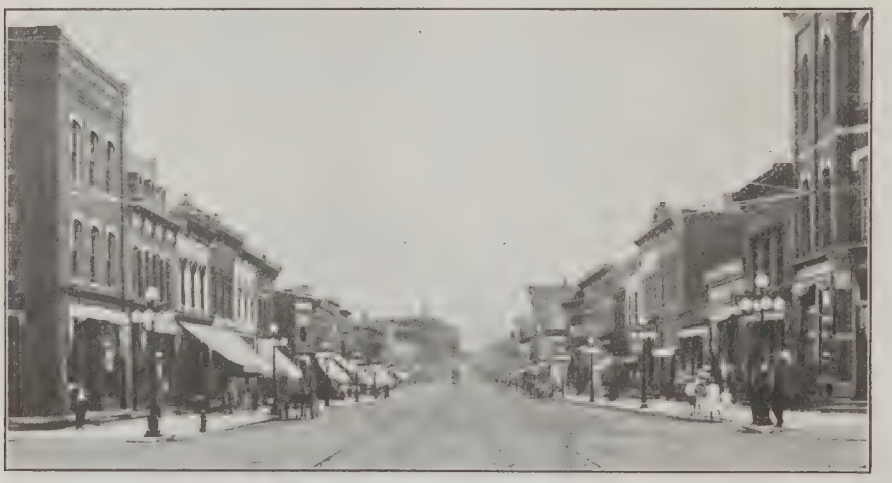


Fig. 1. White Way at Michigan City, Ind.

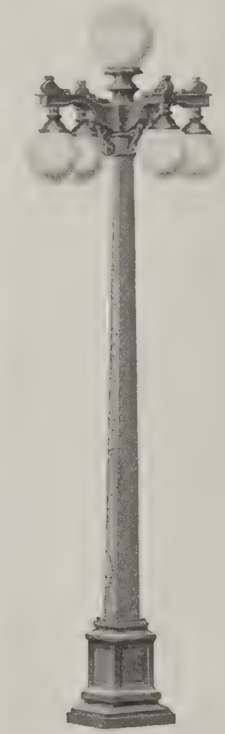


Fig. 2. The Commonwealth White Way Post.

Small Outdoor Substations.

A development of interest in connection with the distribution of power from high tension transmission systems is the installation and use of the outdoor substation. An illustration is shown herewith of such a substation on the system of the Georgia Railway & Power Company, located about two miles from the center of Atlanta, Ga., along the South Decatur trolley line, at the junction of the line to "The Soldiers' Home." The substation is used for stepping up a voltage of 11,000 volts, used in and around Atlanta, to 22,000 volts, at which voltage the substation supplies power to the Stone Mountain-Covington-Monroe transmission line, a total of about 60 miles. This substation of 3,000 Kva. capacity is supplied from the 11,000 volt line from Atlanta, which receives current from various sources, including the new Tallulah Falls power station 90 miles away; the Bull Sluice station, 15 miles away, and two steam stations in the city of Atlanta. The station has been in operation about six months, during which time absolutely no trouble has been experienced, although the nearest operator or attendant is two miles away.

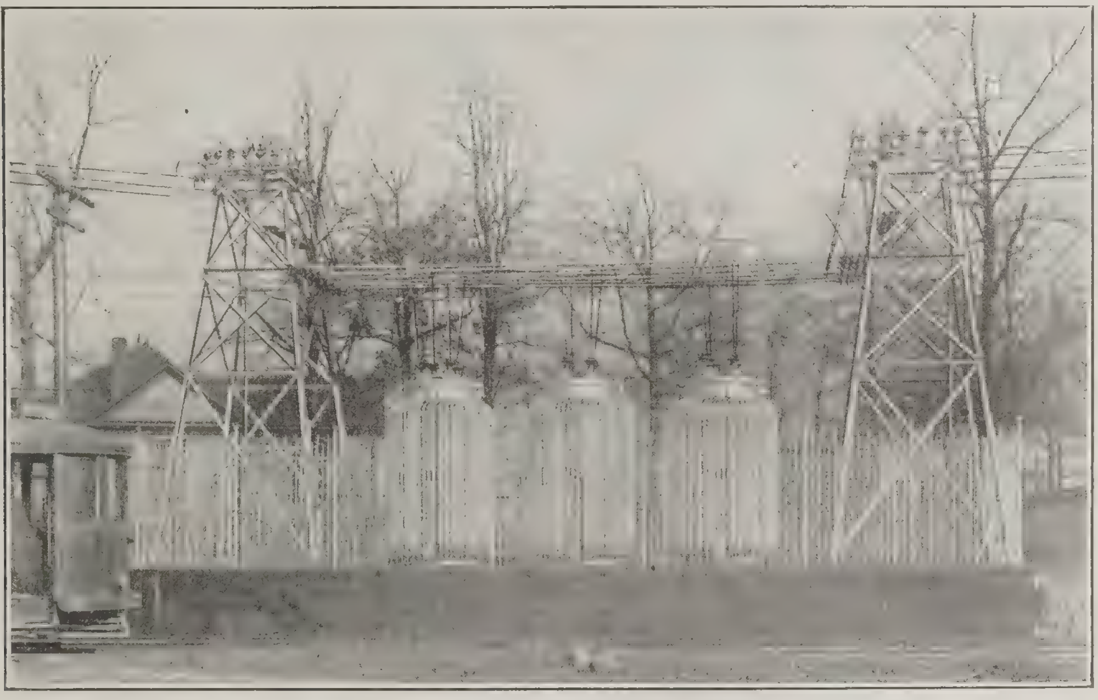


FIG. 1. OUTDOOR SUBSTATION ON SYSTEM OF GEORGIA RAILWAY & POWER COMPANY.

In Fig. 1 a general view of the station, the 11,000 volt line, is shown on the left, and the outgoing 22,000 volt lines at the right. It clearly shows the high tension bus work carried over the transformers, the 11,000 volt bus on the left-hand side and the 22,000 volt on the right.

The two steel structures, each of which carry a three-pole Burke high voltage air break switch, lighting arrester, choke coil and fuse, are of one of the several standard models of outdoor substations built by The Transmission Engineering Company, of Pittsburgh, Pa. The transformers rest on steel rails, partly imbedded in the concrete platform and extending its entire length. This facilitates sliding them under the steel towers, which are provided with a U-bolt, from which tackle can be suspended to lift the coils out of the tanks in case repairs or inspection should prove necessary. This substation was furnished by The Railway & Industrial Engineering Co., of Pittsburgh, Pa.

Electrical Construction News

This department is maintained for the contractor, dealer, manufacturer and consulting engineer.

GEORGIA.

CORDELE. The Chamber of Commerce is promoting a white way system for Cordele, including an ornamental street lighting equipment of 150 posts to cost about $5,000. A plant will be constructed in connection therewith, including a steam engine and generator and the necessary auxiliary equipment.

BUTLER. It is understood that J. M. Harrison is organizing a company to develop a water power at McCant's Mill to supply light and power to this district.

FITZGERALD. The city will purchase additional equipment sufficient to double the capacity of its plant. The cost of same will be around $7,000.

VALDOSTA. A company to be known as The South Georgia Power Co., has been incorporated with a capital stock of $2,500,000 for the purpose of constructing a hydro-electric plant on Wichlacoochee River four miles from Valdosta. Electrical energy will be transmitted by transmission line to Valdosta. Frank Roberts, A. S. Pendleton, C. I. Harrell and John T. Roberts, of Valdosta, are interested and E. S. V. S. Rucker, of Charlotte, N. C., is engineer.

KENTUCKY.

LOUISVILLE. The Louisville Gas & Electric Co. is enlarging its water side steam turbine station and will install four 500 Hp. Babcock & Wilcox boilers with chain grates, ash and coal conveyors and 500 Kw. horizontal turbo-generators with condenser and auxiliary equipment. The engineers are H. M. Byllesby & Co., of Chicago, Ill.

MAYSVILLE. The construction of an electric plant is under consideration by the city.

SHEPARDSVILLE. A company to be known as the Shepardsville Electric Light, Water and Cold Storage Co., is being organized with S. W. Bates as president.

MISSISSIPPI.

BELZONA. The city is planning to double the capacity of its plant by installing additional equipment, including boiler, engine and 100 Kva, three-phase, 2200 volt generator with switchboards. The distribution system will be extended and poles and lamps purchased. J. J. Sisloff is manager.

COLUMBUS. The Mississippi Electric Co. has been organized to build a power plant with a capital stock of $1,000,000. Charles F. Sherrod, F. W. Crosby, and others are interested.

GREENVILLE. The Delta Light & Traction Co., has been incorporated by R. B. Claggett, E. J. Lentz, and F. N. Robertshaw with a capital stock of $200,000. This company has purchased the

Delta Electric Light, Power & Mfg. Co., plant and will improve same.

WAYNESBORO. The Waynesboro Electric Co. has been incorporated with a capital stock of $30,000, by C. C. Green, O. R. Green and J. A. Leggett.

NORTH CAROLINA.

CANTON. Arrangements are being made to install a street lighting system to include 10 arc lamps and 25 incandescent lamps. Further information can be obtained from the mayor.

ELKIN. The Carters Falls Power Co. is being organized for the purpose of building a hydro-electric plant at Carters Falls, three miles from Elkin. This plant will consist of a dam and power house and three miles of transmission system, the capacity being around 200 Hp., and will furnish energy to Elkin and Jonesville. J. B. McCrary Co., of Atlanta, are engineers.

OLD FORT. The construction of a hydro-electric plant at Catawba Falls, near Old Fort, is being planned by the White Coal Co. This company will install 80 Hp. in water wheels and one 600 Kva. generator with switchboard equipment and transformers. A substation will be erected and four miles of transmission line. G. W. Adams, of Asheville, N. C., is engineer.

ROCKY MOUNT. It is understood that a steam turbine and generator together with the necessary auxiliary apparatus will be installed. Same will cost about $15,000.

TENNESSEE.

HALLS. It is understood that the city of Halls is to overhaul the plant of the Halls Water, Light & Ice Co., recently purchased. The equipment will include 100 Kva, three-phase, 60 cycle generator and engine with switchboards, lighting transformers and 7 miles of transmission line. William Hall is manager.

LENOIR. Plans have been prepared by D. R. Shearer, of Knoxville, Tenn., for a water power plant on the Yadkin River near Lenoir.

SPRINGFIELD. The city is planning to construct a power house and install a 300 Kw. steam and electrical equipment, as well as other auxiliary apparatus. G. W. Sawyer is superintendent.

TEXAS.

ARKANSAS PASS. The city will receive bids until May 5th on material necessary to construct an electric light plant and water works system. Griffin O'Neil & Sons, of 1505 Praetorian Bldg., Dallas, Texas, are engineers.

BROWNWOOD. A street lighting system is to be installed by the Texas Power & Light Co., including 162 incandescent lamps and overhead line construction.

CUERO. The Cuero Light & Power Co., will construct two dams on the Guadalupe River and construct a plant that will cost around $250,000. W. M. Ratcliffe is president.

HICO. The Hico Electric Light & Power Co. is to construct 22 miles of transmission line and install additional steam equipment in power plant. H. Gleason is secretary of the company.

SHERMAN. The Texas Light & Power Co. is to spend about $18,000 in enlarging its present steam plant.

Personals.

JOHN BILLAMY TAYLOR has recently announced that his services are now available as consulting engineer on technical investigations, tests, inspections, reports, telephone and telegraph relations to electric light and power systems, earth current surveys, transmission, transformation and distribution of energy by electricity. Mr. Taylor was formerly with the General Electric Company as consulting engineer and as engineer of foreign department. He has established office and laboratory at 23 Lowell Road, Schenectady, New York, and at 100 Broadway, New York City.

W. F. MINOR has been appointed manager of the Holophane Works of General Electric Company to succeed Mr. V. R. Lansingh. Mr. Minor has been connected with the Holophane Works during practically all of his business career, and is known throughout the country as a type of the progressive young business man and as a remarkably successful sales manager.

MR. WILLIAM P. BEAR, formerly of the Sprague Electric Works of the General Electric Company, has joined the forces of the Trumbull Electric Mfg. Co., and will represent them in part of the middle west and also a part of the southern territory.

MR. FRANK J. DUFFY, manager Southern Railway & Light Co., Natchez, Miss., has also been elected president of the company.

Industrial Items.

THE WESTERN ELECTRIC COMPANY, 463 West Street, New York City, has just issued a fifth edition of a copyrighted bulletin, "How to Figure Illumination," which is also a complete catalog of Sunbeam Mazda Lamps. A copy of this bulletin will be mailed to anyone gratis if request is made to the Western Electric Company at any of its branches or to the Sunbeam Incandescent Lamp Division, National Lamp Works of General Electric Company at Chicago or New York.

THE ROBBINS & MYERS CO., of Springfield, Ohio, manufacturers of a line of small motors and fans, has accepted an invitation to membership in the Rice Leaders of the World Association. The membership of this association is composed of leading manufacturing concerns, each representing a different line of industry. The object of the association is co-operatively to exercise the united prestige of members towards the development of their interests individually. The association has adopted an emblem which symbolizes the business principles that have governed the operations of each member's business. These principles are honor, quality, strength and service, and they also form the qualifications for membership in the association.

The Robbins & Myers Co. is adopting this emblem in all departments of its business, thus linking itself with the association and the high standard manufactures that it represents. The officials of the various members were recently gathered together in New York from all parts of the country, in convention, and plans were formulated for future activities of the association. These will be developed as time goes on and will be found to comprise many unique ideas that have interest for the public and the dealer. The whole is calculated, naturally, to react advantageously upon the interests of the members of the association, collectively and individually, the main idea of this association being "cooperation".

THE WHITNEY EVE ELECTRIC CO., Augusta, Ga., has secured the contract for the Empire Building to be erected at Augusta, Georgia. W. L. Stoddard, of New York City, who is the architect for this building, has designed a unique system for laying out the conduit installation in as much as provision has been made for telephones and call bells and the fixtures are to be suspended from conduit nipples toggled in the floor tiling in place of being suspended on fixture studs. J. E. Mair, of the Appleton Electric Company, Chicago, says in referring to this system: "While it is classed as unique, it is not in any manner to be considered radical; to the contrary it portrays an active knowledge of conduit installations on the part of the architect and should have the hearty approval of the electrical contractors."

THE LYTLE ELECTRIC COMPANY of Memphis, Tennessee, has secured the contract for wiring the Post Office and Custom House, in that city, and this installation promises to be a modern conduit installation. Mr. Tate Dawkins, electrical engineer for the Lytle Electric Co., has had long experience in this class of work, having supervised the primary wiring installation in the post office and to complete the general plan of open work, this installation will be made with the Appleton Electric Company's "Unilets."

THE INDEPENDENT ELECTRIC MANUFACTURING CO., of Milwaukee, Wis., has obtained the services of Mr. H. L. Van Valkenburg, who was formerly connected with the Westinghouse Electric & Mfg. Co. of East Pittsburgh as engineer in charge of the rheostat department. Mr. Van Valkenburg later was associated with Allis-Chalmers Company at Cincinnati, and Milwaukee, as engineer in charge of their detail apparatus department, and was afterwards chief engineer of the Walker Electric Co., of Philadelphia. He will have charge of the engineering department of the Independent Electric Mfg. Co., and at the present time is giving his attention to a number of new lines which will shortly be put on the market by this company.

THE APPLETON ELECTRIC COMPANY, Chicago, Illinois, has issued a new and complete catalogue containing 112 pages, fully illustrating and describing its line of Unilets and conduit fittings Many new fittings have been added to the line of Unilets which are fast becoming popular in the south.

THE U. S. LIGHT AND HEATING COMPANY'S Chicago office has been moved from 1013 People's Gas Building to 2335 State street. This change brings the U-S-L Chicago sales office and service station into the same building. The railway department of the Chicago office is now under Mr. H. A. Matthews. Mr. R. E. Stuntz has charge of the battery and started department, and the service depatrment is being looked after by Mr. H. M. Emerson.

THE SIMPLEX WIRE AND CABLE CO., Boston, Mass., has reprinted the report of the Joint Rubber Insulation Committee, recommending a well-defined method of procedure in the analysis of rubber for insulation and other uses. The full report of this committee provides a method of avoiding misunderstandings in working with rubber anlyses, and consists of twenty-four pages. This report was prepared by a number of interests identified with this subject, including the United States Signal Service and Bureau of Standards, the American Chemical Society, two of the large trunk line railroads and four of the manufacturers of rubber-insulated wires, of which the Simplex Company was one.

THE REYNOLDS ELECTRIC FLASHER MFG. CO., of Chicago, Ill., announces that all the legal rights appertaining to Reco Color Hoods were unqualifiedly sustained by the the United States District Court, Southern District of New York, in a decision rendered by the Hon. Judge Hand on March 10, 1914. The suit had been in progress for some time and created considerable interest in the electric sign field. It was proven that the Reco patent on color hoods held by the Reynolds Electric Company is valid and meritorious, and the company will fully protect same against infringements.

TRADE DIRECTORY OF SOUTH AMERICA. A complete revision and detailed classification of the names of South American importers and merchants, made by the American consular officers in co-operation with the Bureau of Foreign and Domestic Commerce, has been published as a section of a new edition of the World Trade Directory. The lists have been brought up to date and are presented in uniform style, with a finding index. A new feature of the listing, so far as the information could be obtained, of (1) the American and foreign agents of South American importing firms, and (2) of the names of the parent firm of branch houses located in various South American cities. The Directory does not aim to include the names of South American exporters, nor are the names of manufacturers given, except those who are, or seem likely to become, purchasers of American materials or merchandise. The publication is a Directory of South American buyers for use by exporters and manufacturers in the United States.

The directory is in octavo form, bound in buckram, and is sold at $1.00 a copy, to cover partially the cost of printing. Those desiring one or more copies of this directory should apply to the Bureau of Foreign and Domestic Commerce for the necessary order blank.

THE DETROIT FUSE & MFG. CO., 1400 Rivard street, Detroit, Mich., has been awarded a silver medal by the First International Exposition of Safety and Sanitation on account of an iron-clad switch design. This medal is given in recognition of the safe features of the switches and the accident prevention qualities.

THE H. W. JOHNS-MANVILLE COMPANY, New York City, advises that the necessity for larger space and better facilities to handle their increased business compelled the Indianapolis, Ind., and Louisville, Ky., branches to seek larger quarters. The new address of the Indianapolis branch is 408-410 North Capitol avenue; that of the Louisville branch 659-661 South Fourth avenue. Both of these branches will include ample warehouse accommodation in addition to show rooms for the display and sale of this firm's varied line of asbestos roofing, pipe coverings, insulating materials, lighting fixtures, automobile accessories, etc. In connection with the last named line, unusual pains have been taken in the equipment of service departments for the benefit of the customers who desire speedy adjustments, repairs or replacements.

THE C. & C. ELECTRIC & MFG. CO., of Garwood, N. J., announce that the Indianapolis territory will temporarily be taken care of by their Cincinnati representative, Mr. F. A. Saylor, Sixth and Vine streets, Cincinnati, Ohio.

SCHWEITZER & CONRAD, 1770-74 Wilson avenue, Chicago, Ill., has issued bulletin No. 3, bearing date of February, 1914, taking up a recording type of synchroscope, and bulletin No. 2 on high voltage detectors. Descriptive matter and illustrations give all the essential details of these devices. The latter replaces the electro-static voltmeter and is useful in pleasing outlines.

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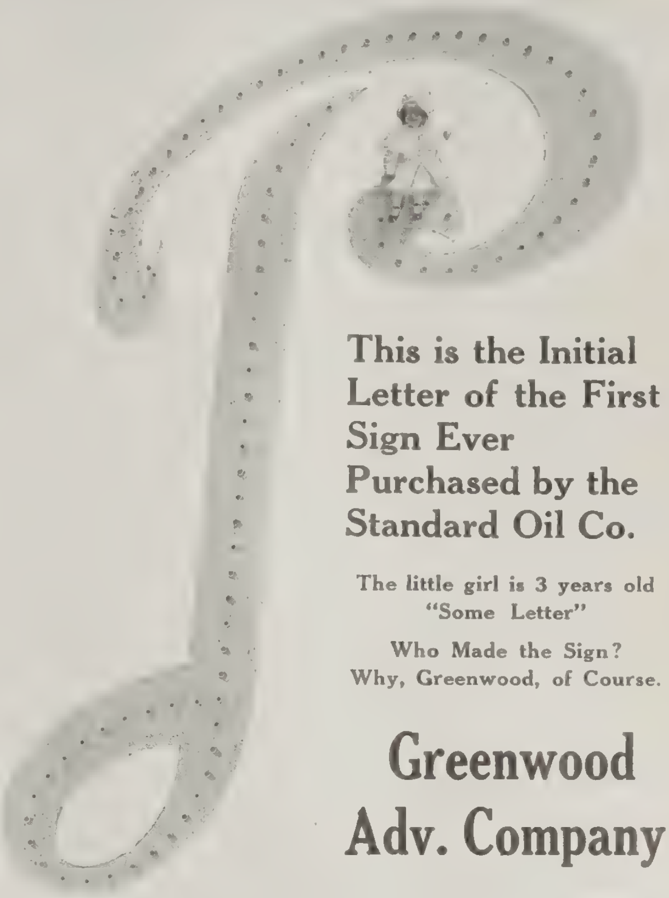

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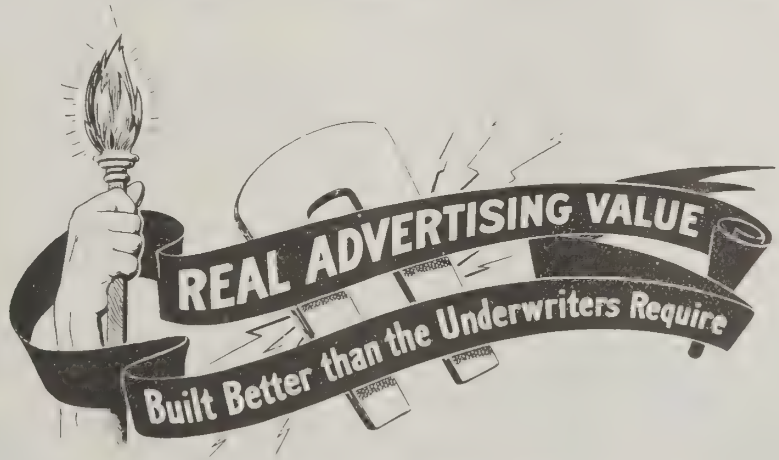
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Bulletin No.	Name.	Company.
7	"Unilets"—Conduit Fittings, Data and Details of Same	Appleton Electric Co., 212 N. Jefferson St., Chicago, Ill.
3508	Exhaust and Ventilating Fan Motors	The Emerson Electric Mfg. Co., St. Louis, Mo.
3913	Sewing Machine Motors	" "
329	1914 Electric Fans	Sprague Electric Works of G. E. Co., N. Y. City.
22	1914 Electric Fans	Century Electric Co., St. Louis, Mo.
21	Single-Phase Motors	" "
B-541	A. C. Control Apparatus	Allen-Bradley Co., Milwaukee, Wis.
B-531	Starting Switches for Small A. C. Motors	Allen Bradley Co., Milwaukee, Wis.
1914	Reference Book on Construction Specialties, with Classification of Equipment Used by Large Companies	Hubbard & Co., Pittsburgh, Pa.
	Handbook on Lighting Glassware	Western Electric Co., New York City.
	How to Figure Illumination	Lighting Studios Co., Madison Ave., New ork.
104	Manual on Testing Portable Instruments, with Diagrams and Detail Directions	Wagner Electric & Mfg. Co., St. Louis, Mo.
11	Vac-M Lightning Arresters for Telephone, Signal, and Alarm Circuits and Low Voltage Power Lines	The National Electric Specialty Co., Chicago, Ill.
200-1	Specifications for CCC Copper Clad Wire	Standard Underground Cable Co., Pittsburgh, Pa.
400-1	Data on Weatherproof Insulated Wires and Cables	" "
18	Small Motors	Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa.
3002-A	Electrical Vehicle Equipment	" "
DS842	Bracket Arms for Direct and Catenary Construction	" "
DS1410	Two-Wire D. C. Switchboard Panels	" "
	Welding and Cutting Equipment	Waterhouse Welding Co., Boston, Mass.
11B	Engineering Data on Mazda Street Series Lamps	National Lamp Works of General Electric Co., Cleveland, Ohio.
8E	Data on Mazda Miniature Lamps	" "
13D	Data on High Candle-Power Multiple Mazda Lamps	" "
3	High Tension Line and Outdoor Substation Equipment	Delta Star Electric Co., Chicago, Ill.
R	Efficient Grounding Devices	The Lord Mfg. Co., Bush Terminal, Brooklyn, N. Y.
	Electric Cooking Apparatus—Stoves, Ovens, Plates, Etc.	Hughes Electric Heating Co., Chicago, Ill.
2	Electric Heating Appliances, Large and Small Ovens, and Other Devices	Despatch Manufacturing Co., Minneapolis, Minn.
242	Control Systems for Newspaper and Magazine Presses	Sprague Electric Works of General Electric Co., New York City.
17A	Manufacture and Use of Shelby Seamless Steel Tubing	National Tube Co., Pittsburgh, Pa.
4	General Catalogue on Electrical Supplies	Electric Supply Co., Memphis, Tenn.
	Pole Reinforcing Methods and Costs	Hubbard & Co., Pittsburgh, Pa.
	How to Figure Cost of Electric Pumping	Goulds Mfg. Co., Senaca Falls, N. Y.

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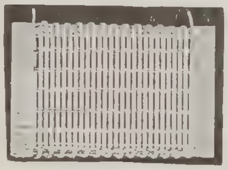

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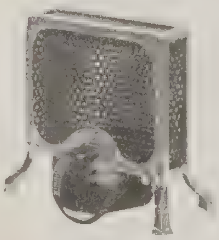

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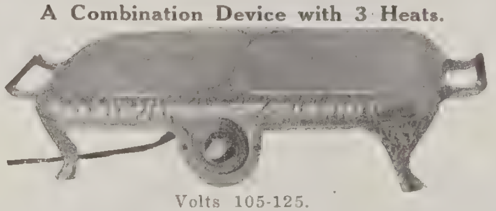

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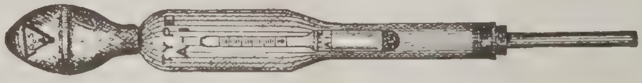

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A Problem for Our Technical Schools and Their Alumni.

When the doors of our technical schools and colleges close this month, literally thousands of young men will be looking for positions. We use the term "position" here advisedly for a very small percentage of these technical graduates will be content with a job nor even employment in an environment that should lead to a position in due time. For some reason best known to young graduates themselves, they seem to believe that a salary is only becoming to their training when expressed in dollars per year, month or week. The suggestion that pay for work shall be based on so much per hour takes away all the attractiveness of employment even under the best of circumstances and possibilities. The reason for this feeling is a problem, a problem for solution by our Alma Maters and their alumni, each and every one working together.

There has been and is at the present time a tendency among professors of technical schools to picture the engineer as one who has little to do, draws a large salary and is "lord of all he surveys." Again too often these fond professors follow and cherish the records of their students who early become presidents of companies, engineering executives and the like, it matters not how these positions are secured. Too often the records of such are held up to aspiring under-graduate students as highly successful examples and standards by which to be measured. The fellows who leave college and bury themselves for some half dozen years in the details of manufacturing, construction or operation, in overalls with greasy hands and face at a salary of twenty cents per hour or $9 to $15 per week, occupy a very small place in the memory of their instructors. Yet by reason of an intimate practical knowledge of a definite line of engineering, such men are the ones who are looked to for ability to work out a reduction in the cost of making some device, to improve the efficiency of some other device or to handle men and processes so that the greatest possible return can be secured.

The success of every engineer who is now considered an authority in his line of work, is due entirely to hard work on his part, manual labor, if you please, disappointment, discouragement and in many cases defeat. Any other picture of his career is untrue as told by the lines that scar the faces of those who stand at the head of the engineering departments in all lines of manufacturing, construction and operation. No amount of pull at the time of graduation can place a man in after years along side of the one who buried himself in the depths of the intricacy of his profession and shook off his false dignity as soon as he left college resolved to do, die or become some sort of a real engineer. These are the types of men who should be sought out to fill engineering chairs in our universities and technical schools and if there existed a record of such, it would not be such a difficult matter to find them when they are wanted. Such men when placed at the head of instruction corps could be relied upon to picture the career of the engineer in its true colors and do a great good, first to the young men yearly electing engineering work, next to their parents who now place too much reliance upon a technical training as a guarantee of engineering ability and finally do a great good to the engineering profession by making it possible to secure more engineering graduates who have some idea of what an engineer is expected to know and do to earn even a moderate salary.

As examples of men whom we consider of the above type and now occupy chairs in technical schools in a most efficient manner are: Dexter S. Kimball, of Cornell University; Chas. F. Scott, of Yale, and Francis B. Crocker, of Columbia University. The records of these three men are such that if published would not only be inspiring but as interesting as the best fiction of the year. What these men have accomplished they have done for themselves and no technical school or pull has been entirely responsible, although the former has been a great asset.

As a summation of what the technical school can furnish the engineering graduate, we quote here an editorial expression from a recent issue of the *Sibley Journal of Engineering* which we are led to believe is the opinion held by the engineering departments of Cornell University: "Every year thousands of young men graduate from our engineering colleges and universities. After spending four years (perhaps more) studying books, they finally discover that what has been done in school is but a small part of what they must do before they can call themselves engineers. Many a man thinks that an engineering college should turn his son out after four years a full-fledged engineer. Probably after laboring under the same delusion for several years the young man himself as a senior realizes the actual facts. There is no engineering college in existence, no matter how efficient its staff of instructors, nor how well equipped its laboratories, nor how complete its curriculum, that can transform a young man with little or no practical knowledge into a finished engineer.

"The primary object of any engineering college is to produce from a heterogeneous mass of raw material men who can think and who have that fundamental knowledge of engineering upon which they can build a superstructure of success. He who has a thorough knowledge of the fundamentals and their application is already advanced on the road to success.

"Furthermore it might be said that the college enriches the personality and congeniality of its graduates. This factor depends almost wholly with the person. We are of the opinion that the knowledge gained from books and in the laboratory is but a small part of the true education leading to success. The education gained from personal contact with professors and students of various colleges in a large university where all personalities can be found—the study of the human element and its makeup—is half of the fuller education. But how many students grasp the full value of this half of their education? The sales engineer finds it essential to progress; the foreman and superintendent must deal with and lead men, each one representing a differently assembled machine. If each graduate has secured a good fundamental knowledge, acquired the ability to think quickly and clearly, and developed that indescribable power to penetrate the make-up of man, he has received the fullest blessing that a college engineering course can give him."

To our knowledge no technical school has openly gone on record with statements of hammered down facts such as these. This outline of what may be expected from a technical training is good enough to be inscribed over the portal of every technical school as a warning to the student who may hold a different opinion. In such a position it would save much disappointment and enable a school to handle a product from which a definite result can be expected for the fellow who will turn back on account of discouragement at the start may complete a college course but not get far afterward. A place in the curriculum of every technical school should be given to a course at least two years in length, discussing engineering difficulties and failures both of men and principles. When alumni and engineers are asked to speak before students, this should be their subject. Few will refuse to cooperate in this regard for he who has been and now is successful in engineering work is seldom ashamed of his past or his failures. Those who refuse are not qualified to talk to engineering students and their successes are not real in all details.

Let all of us who are in engineering work lend our support in making the primary object of an engineering college as set forth here a striking reality, by filing a plea with our Alma Maters to fill vacant chairs and some that are not vacant, with worthy engineers, men who have done things and become worthy on account of their own enterprise and initiative and to weed out those who have shown themselves inefficient and holding back young engineers on account of pedagogic inclinations or lack of engineering experience.

An Announcement.

On May 1st Mr. J. T. Rose resigned as vice-president and manager of sales of the Atlanta Steel Company to accept the position of treasurer with the W. R. C. Smith Publishing Company. Mr. Rose came to Atlanta in 1901, leaving the position of manager of sales with the American Bridge Company of New York, and has been successful in building up the business of the Atlanta Steel Company until it is now one of the largest in the South. He began in the steel business in Toledo, Ohio, being transferred to Pittsburg and New York before coming South. He is a graduate of the Ohio Northern University, a member of the Engineering Association of the South and president of the Atlanta Builders' Exchange.

On account of an extensive experience, Mr. Rose has a wide acquaintance in the iron, steel and machinery industries, particularly throughout the South, making his association with a technical journal such as *Electrical Engineering* a valuable asset to the interests it serves. His connection with the W. R. C. Smith Publishing Company is in accordance with a well-established policy of its founder and president, Mr. W. R. C. Smith, to build up an organization of efficient and trained experts in all departments essential to the publication of *Electrical Engineering, Southern Engineer, Cotton,* and *Southern Machinery.*

Cleveland Electrical Exposition.

At the Coliseum, Cleveland, Ohio, May 20 to 30, an interesting exhibition of electrical equipment was held. More than 100 electrical manufacturers, jobbers and dealers occupied booths, in which were shown the latest developments in electrical manufacture, all kinds of electrical equipment, appliances, etc. One of the most interesting exhibits, and one of the largest, was that of the United States Government, showing a model of the Panama Canal and a model of the United States steamship Michigan.

The Tallulah Falls Development of the Georgia Railway and Power Co.

BY C. E. BENNETT, ELECTRICAL ENGINEER WITH C. O. LENZ, CONSULTING ENGINEER, NEW YORK CITY.

Section 2. Details of Substations, Including One at Atlanta (Ga.), the Largest of Its Kind in Existence.

In the May issue of *Electrical Engineering,* the hydraulic and electrical details of the Tallulah Falls plant of the Georgia Railway & Power Company were presented. In what follows, the details of the sectionalizing, cross-over and transformer substations will be taken up, including the Atlanta Boulevard station, which is the largest outdoor substation yet built in this or any other country. The substations of the system are located at Atlanta, Newnan, Marietta, Gainesville, Cartersville and Lindale, Georgia.

The smaller substations installed throughout the entire system are of the semi-outdoor type, designed so that the high tension switching structure forms an integral part of the transmission line, as shown in Fig. 2. At each proposed substation site the high tension structure is to be erected along with the transmission towers, in this way obtaining the advantage of a sectionalizing and cross-over station from the very start, and avoiding any shut-down of the lines when it becomes necessary to equip the complete station. Nine of these sectionalizing structures have been located at advantageous strategic points in the lines, and five have been built as complete transformer stations, with capacities varying from 1,500 Kva. to 6,000 Kva.

Simplicity and symmetry have been the guiding principles of design, and a standard outdoor high tension structure and low tension building have been evolved to take care of a maximum ultimate capacity of 12,000 Kva. in four banks of 1,000 Kva. oil insulated, self cooled transformers, 110,000 to 11,000 volts. Views of such an installation are shown in Figs. 2 and 3, which are of the Gainesville substation.

Each transformer has four 2.5 per cent reduced voltage taps on both the H.T. and L.T. winding, thus allowing for a 10 per cent variation in voltage either way. The sectionalizing and cross-over features are effected by the use of horn-gap disconnecting switches mounted on the lateral trusses of the latticed tower structures, all three poles of any switch being operated simultaneously by a lever and rod mechanism located at the base of the tower. It is the intention of the designers that these switches shall only be used for breaking the charging current or very light loads. In this way a very flexible arrangement is obtained without the expense and complication of H.T. oil switches at every sectionalizing or cross-over point. At each substation there are two K-15 oil switches connecting the 110,000-volt lines to the transformer bus, to which bus any bank of transformers may be connected by means of a T.P. horn-gap disc switch. Each K-15 switch is protected from the weather by a sheet steel house of simple construction, and lightning protection is afforded by an outdoor type electrolytic arrester. Additional protection from lightning

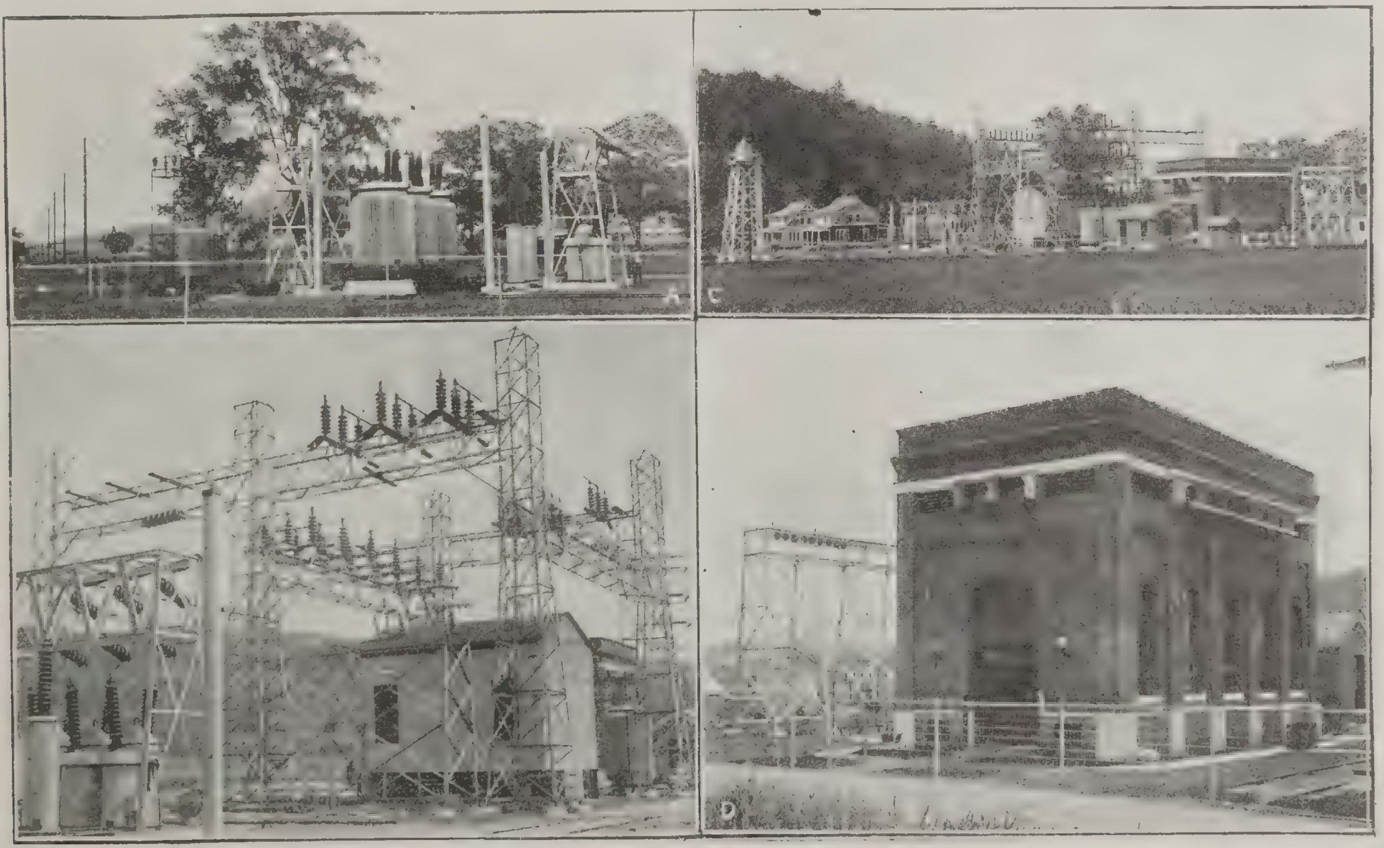


Fig. 1. Views of Lindale (Ga.) Substation Showing Arrangement of Apparatus and Transmission Line to Rome.

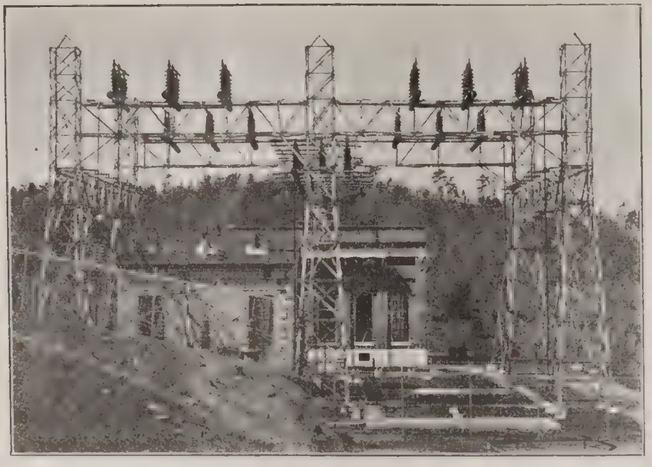


Fig. 2. View of Gainesville Substation Showing Standard High Tension Structure and Switching Arrangements.

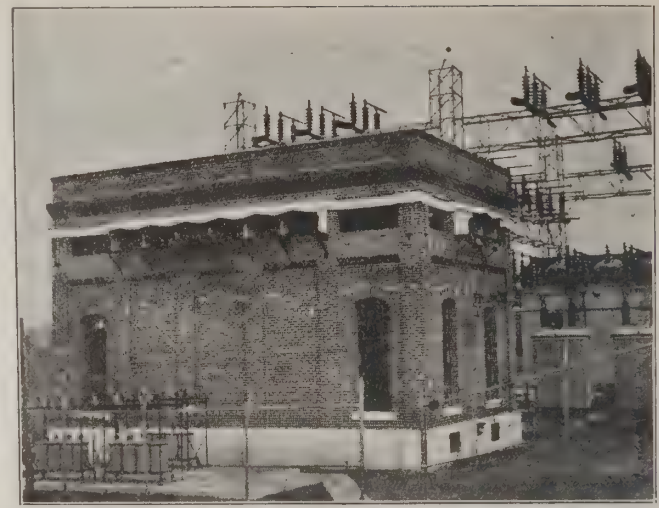


Fig. 3. Showing Standard Construction of Low Tension Building at Substations.

discharge is obtained by continuing the tower line ground wires over the substation tower structures.

The standard low tension building is of brick, built for an ultimate capacity of 12,000 Kva. at 11,000 volts. Provision is made for four incoming 3-phase lines and four outgoing 3-phase feeders, all lines entering and leaving the building overhead; and 11,000-volt wall entrances of standardized design have been provided on all four sides of the building. In addition to the above 12,000 Kva. capacity, each substation has provision for a synchronous condenser, a 600 Kw. bank of 11,000 to 2,300-volt transformers for local distribution and one 75-light constant current transformer for series lighting. At each substation there will be built a hoist tower for transformer inspection and repairs.

ATLANTA OR BOULEVARD SUBSTATION.

The Atlanta or Boulevard substation is the largest one of the system, and, as already mentioned, the largest outdoor station in this country. It is located on the north side of Atlanta's city's limits, on Boulevard avenue. The design of this station provides for an ultimate transformer capacity of 60,000 Kw. in 110,000/11,000-volt transformers, with a present installation of one-half of this capacity—namely, 30,000 Kw.—consisting of nine 3,333 Kva. transformers. At present two incoming 110,000-volt and two outgoing 110,000-volt lines are connected with this station, with provisions for two additional incoming or outgoing lines, making a total of six 110,000-volt lines. The two incoming lines now installed are those from Tallulah Falls, with one of the outgoing lines leading to Newnan and the other to Lindale, Ga.

The bus arrangements are carried upon latticed steel structures of a design similar to that of the steel transmission towers, with angles, channels and standard sections bolted together. The high tension wiring is divided into two sections, know as the North high tension bus bars and South high tension bus bars, which are electrically joined together by a tie switch. All the high tension wiring as well as transformers and their circuit breakers are located on the outside, with no protection whatever against the weather. In order to make the construction as permanent and stable as possible, the high tension wiring has been strung along the lines of the standard catenary construction, with copper tubing bus bars supported by hangers from

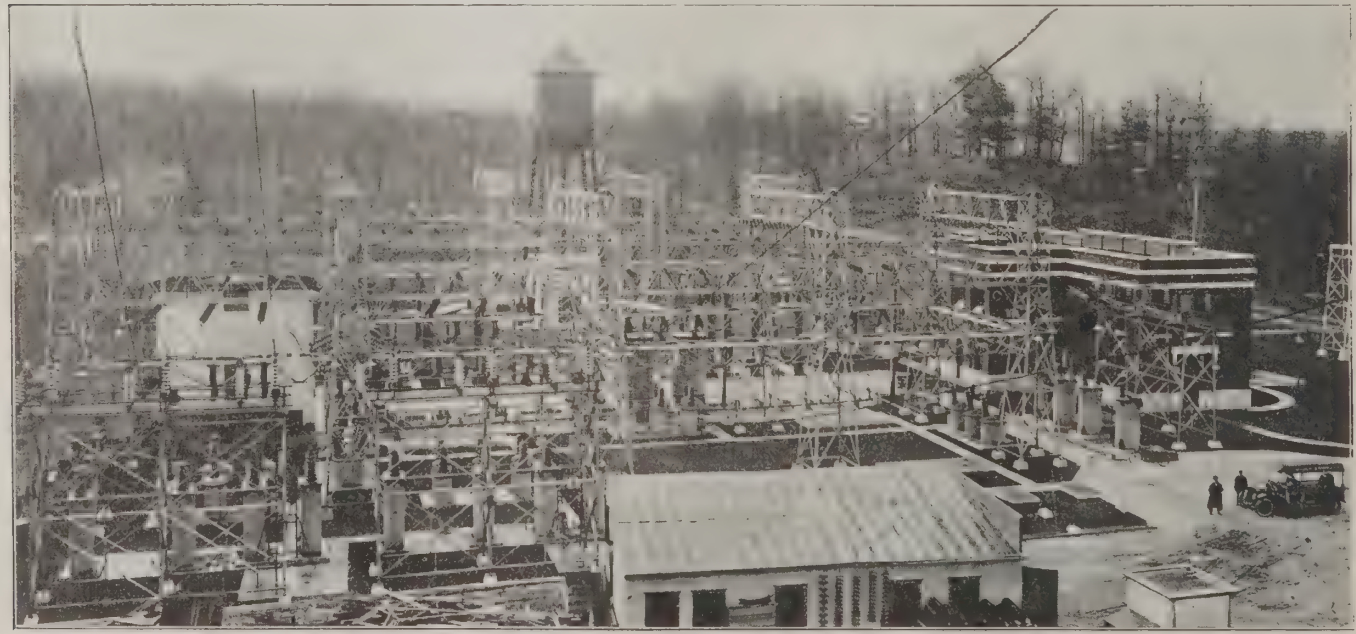


Fig. 4. A General View of the Atlanta Boulevard Substation, Showing the Trouble Station in the Foreground.

a ½-inch copper-clad messenger, which is in turn insulated from the steel framework.

In general, the entire layout consists of high tension frames, repair shop, water storage tank and storage basin, low tension or 11,000-volt building and 11,000-volt outgoing line frame, all shown in Fig. 4. The entire property has been graded and sodded, with concrete sidewalks and crushed stone driveways. An ornamental picket fence has been constructed on the front of the property, as shown in (B) of Fig. 5, and one consisting of concrete posts, with wire strung between them, surrounds the other sides.

HIGH TENSION BUS STRUCTURE AND WIRING.

One side of the high tension bus structure and the catenary arrangement of the bus bars supported by the trusses is shown in (D) of Fig. 5. One feature of the high tension wiring which was given special thought, and which is installed, is the disconnecting switch, which has a protection against sleet over the jaws or contact-making surfaces. These disconnecting switches are carried upon triangular trusses so as to place the blades at such an angle that they may be easily operated from the ground. The upper jaw of the switch is covered with a cast iron covering, and has a special spring-latch catch to hold the blade in position when the switch is closed. The sleet hood makes it possible to open or close the switch even during a sleet storm when it is covered with a film of ice.

All of the exterior equipment has been painted a dull marine gray, with black striping. This was done to provide a more non-absorbing medium when exposed to the hot rays of the summer sun. The foundations for the ultimate equipment are already installed, so that when it becomes necessary to add to the equipment from time to time, the only apparatus necessary will be electrical equipment.

Lighting fixtures have been installed throughout the entire structure, so that the grounds are well illuminated at night. The reflectors over each lamp are of enameled porcelain of special design, so arranged that they cannot throw the light on the high tension wiring. It was thought that with such an arrangement defective insulators could be easily detected at night. There are also waterproof plugs at different parts of the exterior to which a portable plug can be attached in making repairs.

The high tension structure was all thoroughly galvanized before erection, and the base of each rectangular column is bonded by an expanded rail bond of No. 4/0 wire to a set of grounded ring buses, which are in turn connected to each other. There are four of these ring buses, and all the apparatus is also thoroughly bonded to them.

The space allotted to eighteen single-phase 110,000/11,000-volt transformers, nine of which have already been installed, is shown in (C) of Fig. 5. Running alongside of and parallel to the transformer foundations are main transfer tracks with a suitable truck for handling the transformers. At the end of the two main transfer tracks opposite the repair house, or adjacent to the low tension building, are two turntables, with a connecting track between them.

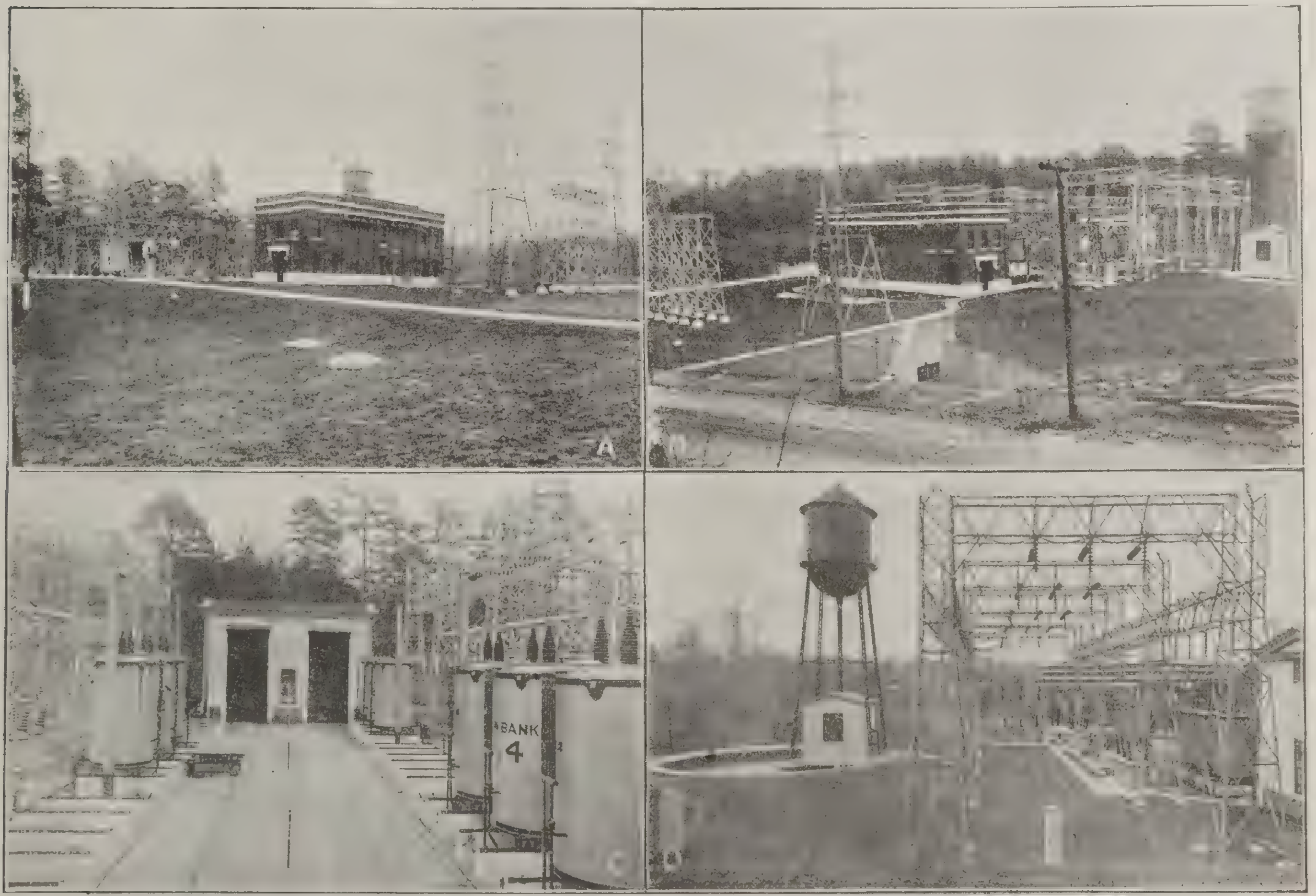


FIG. 5. VIEWS OF THE ATLANTA SUBSTATION. (A) SHOWING NORTH SIDE OF LOW TENSION BUILDING AND HORN GAP AND CHOKE COIL STRUCTURE. (B) SHOWING SOUTH SIDE OF STATION. (C) SHOWING TRANSFORMER BANKS, REPAIR SHOPS AND ARRANGEMENTS FOR HANDLING TRANSFORMERS. (D) SHOWING HIGH TENSION BUS STRUCTURE, WITH CATENARY ARRANGEMENT OF BUS BARS; ALSO WATER STORAGE TANK AND BASIN AT LEFT.

This arrangement makes it possible to take a transformer from one bank to replace one in any other bank by means of the transfer truck. Leading from the turntables at 90 degrees to the main tracks is the track which extends to the main roadway, so that equipment can be unloaded from wagons on the truck and hauled direct to repair shop.

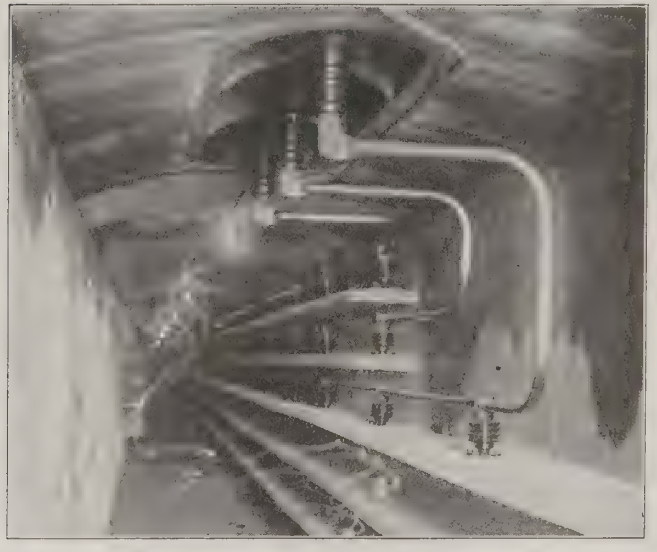


FIG. 6. LOW TENSION LEADS FROM TRANSFORMERS AND TUNNEL TO LOW TENSION BUILDING.

The repair shop, shown in Fig. 5, is constructed of steel, "hy-rib" and plaster, with two large doors of the steel curtain type on the front side. This building is used for making repairs to the large transformers in bad weather or when it is necessary to dissect a damaged transformer. There is installed on the interior of this building a hand-operated 10-ton crane, oil filter press, and necessary oil storage tanks, as well as a small machine shop. Having this house available for repairs obviates the use of space in the main low tension building for this purpose, and thus does away with the dirt, grease, etc., which is necessarily present where repair work is done.

TRANSFORMERS AND ARRANGEMENTS.

The transformers are of the water-cooled type, and suitable headers are carried along parallel to the main transfer tracks, with the necessary valves for letting the water in and out of the different transformers. There are also oil mains connecting the different transformers with the filter press and oil storage tank, so piped that the oil may be forced in either direction through the system.

The low tension leads are carried from the rear side of the top of the transformers over to a delta bus supported on pipe framework, and from this framework down through roof entrance bushings set in iron castings of special design into the top of the tunnel, which runs parallel to the line of transformer banks. In Fig. 6, which is a view in the 7-foot tunnel, can be noticed several of these roof entrance bushings. The leads, after entering the tunnel through these roof entrance bushings, are carried along concrete shelves, and supported by porcelain insulators, into the low tension building, where they are connected to the respective oil switches. All of these leads are made of 15-16-inch tubing so as to give mechanical strength.

LOW TENSION BUILDING.

Each and every phase of the low tension wiring is isolated by masonry barriers, so that in case contact should occur at any one place it will involve only the one phase. Fig. 7 shows an end view of the bus structure on the first floor of the low tension building. This structure is made of buff pressed brick and alberene stone, and the barriers at the top of transits are held in place by iron clips.

The operation of the entire station is controlled by means of pull-button switches from a control switchboard. The high tension mimic buses are designated on the board by brass strips, and the low tension buses by copper strips. All of the switches are operated by a 250-volt, 40-amp.-hr. storage battery, and two 10 Kw. motor-generator sets are used to recharge these batteries. This battery equipment was installed so that, should any interruption occur to the high voltage service, the switches could still be operated.

The second floor of the low tension building, which contains the 11,000-volt oil switches, is shown in Fig. 8; also the location of the outgoing lines on the side walls. There is a total of fifteen 200-amp., 11,000-volt outgoing lines, nine of which are underground and six overhead, and also a station group switch. Two banks of three 10 Kva., 11,000/110/220-volt and three 25 Kva., 11,000/440-volt auxiliary transformers, furnish the energy for lighting, pumps, motor-generator sets, etc. At each end of this room are placed the arresters of electrolytic design, which are connected to the ends of the four bus sections. The general arrangement of the switches consists of two bus sections, each containing two bus bars, the ends of which are cross-connected through an oil switch, forming a double-U bus arrangement, the feeders of which can then be switched to either section of the section bus. Facing the front of the oil switch, there is mounted on the left of the motor on each of these switches a four-pole knife switch, which is used to isolate the control by cutting out the close and trip and the lamp circuits, making it impossible for an operator

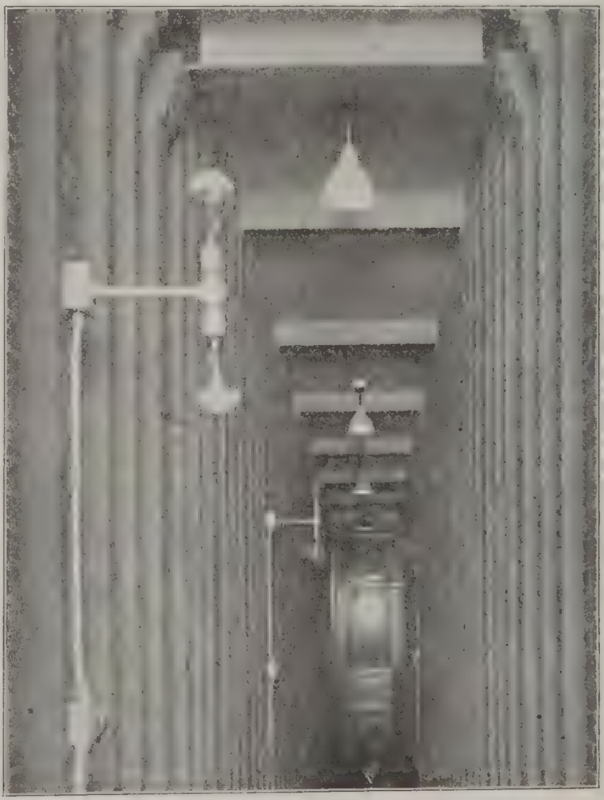


FIG. 7. THE BUS STRUCTURE ON FIRST FLOOR OF LOW TENSION BUILDING.

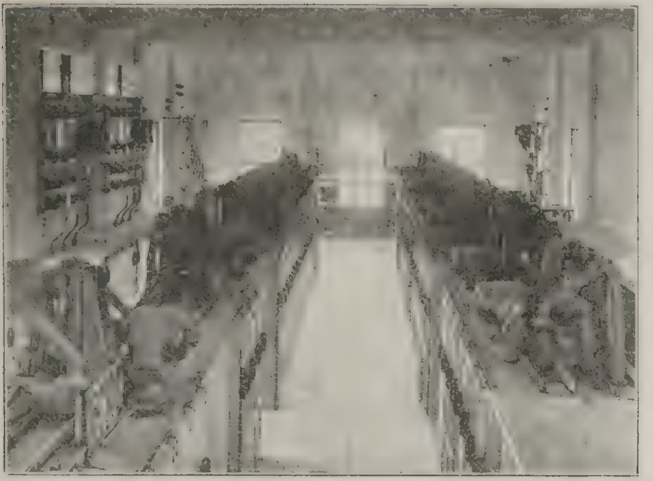


FIG. 8. SECOND FLOOR OF LOW TENSION BUILDING, SHOWING OIL SWITCHES AND OUTGOING LINES AT LEFT.

to throw this switch from the control board when it is intentionally cut out for repairs. All of the masonry on this floor is also of buff pressed brick and alberene slabs. The shunt transformers are carried in separate compartments of the same general design and construction as those of the switch structure.

The low tension building has concrete foundations, and the superstructure is of red-faced brick, with white marble trim and parapet. The roof is of concrete slab and tar and gravel construction. The window frames are of steel and are top-hinged. It is possible to view the entire outdoor equipment from the control room. This building is 81 feet by 25.75 feet, and the control room annex is 27 feet by 18.5 feet. The first floor of the annex contains the battery room, shower baths, toilet, etc. The second floor consists of the control room itself, which contains the control board, the motor-generator sets, charging switchboard and telephone equipment, as well as a general office for the operators in dispatching the loads of the system and operating the station.

All of the incoming and outgoing high tension lines are fitted with lightning arresters, standard horn-gaps, and choke coils. The high tension choke coils are so placed that their connection with the line is by means of a right-angle bend, while the connection through to the electrolytic tank is a straight through connection, along the direct path to and across the horns and into the arrester bushing. Between the low tension building and dead-ending frame, as can be seen in (A) of Fig. 5, the outgoing 11,000-volt lines are fitted with an insulator. From the front of this insulator down to the lightning arrester frame and back again to the rear of the insulator is a No. 4/0 copper wire, forming a somewhat original scheme known as the inverted hairpin. At the sharp bend at the bottom of the pin the connection is made to the lightning arrester frame, and it is supposed that a discharge or surge coming in along the line, instead of making the sharp bend at the point where this connection is made, will go through the lightning arrester tank. This arrangement has been very satisfactory.

WATER SUPPLY AND STORAGE.

In order to secure water for cooling the transformers, it was necessary to drill wells, and four have been driven to a depth of about 450 feet, and two of them piped up for use in connection with compressed air for forcing the water from the well to the concrete catch basin at the top. These catch basins are at an elevation of several feet above that of the main storage basin, and the water is allowed to feed from them into the main storage basin by gravity. In Fig. 7 can be seen the main reservoir, which is about 11 feet deep and 61 feet in diameter. Above this reservoir, and resting on a concrete base, is the 50,000-gallon elevated storage tank, about 75 feet above the water level in the main reservoir. A vertical submerged centrifugal pump forces the water from the reservoir into the tank against the head of water there, whence it is fed by gravity through the system of cooling pipes. There is installed in the house, directly under the storage tank, known as the pump house, an air compressor with a capacity of 150 cubic feet for pumping air for the deep wells, with provision made for the installation of additional equipment similar to that now installed. An arrangement is also provided for discharging the water from the tank directly into the main reservoir without going through the piping system; or, should it be desirable to do so, the water may be discharged from the tank into waste and cooler water pumped into the tank for cooling the transformers during the hot summer months. The reservoir and tank are both provided with electrical float switches for regulating the depth of water. The pump and air compressor are supplied with energy from the three-phase, 75-Kw., 440-volt bank of transformers.

Most of the electrical equipment in the Atlanta substation has been supplied and installed by the General Electric Company. This includes the transformers, lightning arresters, low tension oil switches, control equipment and four of the high tension oil switches. The latter are known as Type K-22, and are the first 110,000-volt switches for outdoor service that this company has built. Four of the high tension breakers were furnished and installed by the Westinghouse Electric & Manufacturing Company and are of its standard GA type. The air compressor and deep well equipment was furnished by the Ingersoll Rand Company and is fitted with Cutler-Hammer control. The large storage tank was furnished and erected by the Chicago Bridge & Iron Company, and the local lighting, miscellaneous motor equipment and oil and water piping were installed by the Tucker Electrical Construction Company, of New York City. The grading, construction work, etc., were done by the Northern Contracting Company. The steel structures were furnished by the Alfred E. Norton Company, of Philadelphia, and some miscellaneous steel equipment by R. D. Coombs & Co., of New York.

The next section of this article will take up details of transmission lines and telephone circuits run on line towers.

Cost of Norwegian Hydroelectric Plants.

According to Consul General M. J. Hendrick, in a recent issue of the *Daily Consular and Trade Reports*, the construction cost of water power plants in Norway varies from 100 to 200 crowns ($26.80 to $53.60) per horsepower for large water plants, and from 100 to 500 crowns ($26.80 to $134.00) per horsepower for small plants. The rate at which the power is sold to consumers varies from 30 crowns ($8.04) for large enterprises up to 50 crowns ($13.40) for small ones, per horsepower per year, 24 hours per day service.

Engineering Considerations in Connection With Passenger Elevator Systems

BY M. WILLIAM EHRLICH, CONSULTING ENGINEER, NEW YORK CITY.

Section 3. Summary of Operation—Division of Service—Starting and Running Current—Motor Power Requirements—Electrical Installation Data.

IN the foregoing considerations certain rules were laid down for the computation of the average work of an elevator, and in order to facilitate the ready understanding of the various formulas given, Table 1, embodying the computations, is presented. The various headings included, are numbered in respective order, from 1 to 12, so that an explanation of the items considered will not be confusing. Under colmun 1, is listed the heights of buildings; with the assumed floor areas extending the full height of the structure given in column 2. In column 3 is listed the actual square feet of car area now provided in many buildings of similar floor space having an adequate service. This is intended as a guide where the considerations in planning the building have included a means of accommodating the standard size elevators most suitable for that building, and wherein serious attention has been given to the disposition of the cars. But on the other hand, the values listed may also be used to advantage, in proportioning the number of elevators required under any conditions, and where the physical aspect of the building does not allow for an economic disposition of the elevators. Any conservative unit-area best suited to the conditions may then be alloted for each car, and thereby solve for the number of elevators necessary. Columns 4, 5 and 6 give the numbers of cars for various standard unit-areas, while column 7 is that number as computed by formula No. 1.

The local and express round-trip time for different running speeds is given in columns 8, 9, 10 and 11, and the value for (f) as given in formula No. 2, is listed in column 12. It will be noticed that in columns 8 and 9 the time occupied in traversing the height of buildings exceeding eighteen stories is slightly more than would actually prove economical. It might be well therefore to point out that the speeds of local elevators for high buildings might be increased to advantage and whether the service be either local or express, it is not advisable to exceed a speed rate of 600 feet per minute.

In order to rectify this condition, under the speeds considered, the number of express elevators must then be more than half the total system, and a sub-division of express service proper, is also necessary. It might prove of interest to state that in the new Municipal Building at New York City all the elevators both local and express are designed to run at a speed of 600 feet per minute and in the Woolworth Building, the designed speed has been increased to 700 feet per minute. Such high running speeds were made permissible by the recent modifications in the city regulations affecting passenger elevators, but they only allow for a maximum local speed of 500 feet per minute and a 700 foot speed for express elevators.

Where a sub-division of elevators is maintained, those cars serving the full height of the building are commonly termed long-run elevators and the number of machines serving any one level are usually classed as a "bank" of elevators.

In studying the daily operation of the systems by the figures given in Table 1, it should be understood that up to a height of 18 stories all elevators traverse the full height of the structure, but it sometimes becomes advisable to establish an express service in buildings extending over sixteen stories. For buildings exceeding this level the local runs terminate at the predetermined floor as listed in column 12, at which landing the express elevators make the first stop, and then serve the remaining portion of the upper floors as a local car.

The phase of the question previously considered covering the vertical transportation of passengers in modern office buildings, was that of the economic division of service and the number of elevators required to make that service adequate under average operating conditions and some electrical data that may be useful in constructional considerations follow.

The elevator equipment as usually supplied by the manufacturers includes the car, machine, motor and incidental appliances. Of the various sizes of electric motors found in elevator practice the following are common, and it may prove of interest to note the current consumption for a pressure of 230 volts, direct current, as below:

Motor Size	Starting Current.	Running Current
20 H. P.	102 Amp.	74 Amp.
40 H. P.	202 Amp.	147 Amp.
60 H. P.	292 Amp.	213 Amp.

These figures are based on the results of tests, and do not represent copies of the motor name-plate inscriptions. Referring to motor sizes, it is often helpful to be informed as to the horsepower required for any installation under consideration, and the diagram given below, Figure 1, may be used for this purpose. For any combination of load and

TABLE 1. DATA ON ELECTRIC PASSENGER ELEVATOR

1	2	3	4	5	6	7	8	9	10	11	12
Building		Number of Elevators Required					Round Trip Time in Minutes.				f or
Number of Floors	Gross Area in Sq. Ft.	Total Sq. Ft. of Car Area	Cars at 25 Sq. Ft.	Cars at 30 Sq. Ft.	Cars at 40 Sq. Ft.	By Formula No. 1	Tl at 350 Ft. Per Min	Tl at 500 Ft Per Min.	Te at 500 Ft. Per Min.	Te at 600 Ft. Per Min.	Express Run, in Floors
8	80,000	89	4	..	..	4	1.3	...	...	...	..
10	100,000	111	4	..	..	4	1.7	...	...	...	..
12	120,000	133	5	..	..	5	2.0	...	...	...	.
14	210,000	262	11	9	..	9	2.4	3.1	...	...	..
16	240,000	300	12	10	..	10	2.7	2.4	1.6	...	10
18	270,000	337	14	11	..	11	...	2.7	1.8	...	11
20	300,000	375	15	13	10	13	...	3.0	2.0	1.8	12
25	375,000	577	..	19	15	16	...	...	2.5	2.3	15
30	800,000	1221	..	40	30	33	...	...	3.0	2.7	17

speed, the necessary motor power may be immediately found. In order to make the use of this diagram clear, a short explanation is given. The speed and load combination is assumed or fixed, and by following the vertical line of speed to the point of intersection with the diagonal line of load, the size of the motor required is found by following the horizontal line to the scale of motor horsepower. An example may prove of interest. For the purpose of this illustration a speed of 400 feet per minute is assumed, with a combined load of, say, 2,500 pounds. These conditions would well fulfill the service of any modern building from 13 to about 23 floors in height. Following the line marked with an arrow, from the speed of 400 feet, the point of intersection is then at the load of 2,500 pounds. From this point follow the line as indicated to the scale of motor sizes, and the result is about 40 horsepower.

The size of motor is only one of the basic considerations, and is really not of the greatest importance. This should be understood to mean that when the elevator manufacturer provides the elevator mechanism, the right size of motor is, therefore, supplied. The importance of this point really lies in the consideration for wiring the apparatus. The elevator contractor does the wiring between the controlboard and the motor, but the feeders must be provided for the wiring attachments to the controller. The controlboard is usually of the magnet type, allowing for automatic control of the motor, and thereby governing the amount of current used.

The tabulation given below, Table 2, is designed to aid in the selection of the proper size of feeders for any direct current motor of 230 volts to be used for elevator operation. The carrying capacity or the maximum permissible load for the wire sizes given is that governed by the fire underwriters. As it is customary to place the motive apparatus at the head of the shaft, and the source of current supply is not always adjacent, necessitating a long run for the feeders, the drop in voltage must be considered. An additional column gives the approximate length of feeders for a drop in voltage not to exceed 2 per cent. The conduit size allows for a two-wire system, in which both wires may be pulled through. The outside diameter of the conduit is also given, for sometimes space conditions will not permit the use of large size pipes.

TABLE 2. WIRE AND CONDUIT SIZES FOR ELECTRIC ELEVATORS, 2 WIRE, 230 VOLT, D. C. SYSTEMS.

Motor Horsepower	Wire		Maximum Run or Distance in Feet for 2% Drop	Conduit	
	Underwriters Capacity, Amperes.	Size of Each Wire		Size for Two Wires	Outside Diameter
15	76	No. 3	116′	1¼″	1.66″
20	90	No. 2	164′	1¼″	1.66″
25	127	No. 1/0	186′	1½″	1.90″
30	150	No. 2/0	198′	1½″	1.90″
35	177	No. 3/0	212′	2″	2.37″
40	210	No. 4/0	226′	2″	2.37″
45	235	250,000 C.M.	238′	2½″	2.87″
50	235	250,000 C.M.	238′	2½″	2.87″
55	270	300,000 C.M.	248′	2½″	2.87″
60	300	350,000 C.M.	260′	3″	3.50″

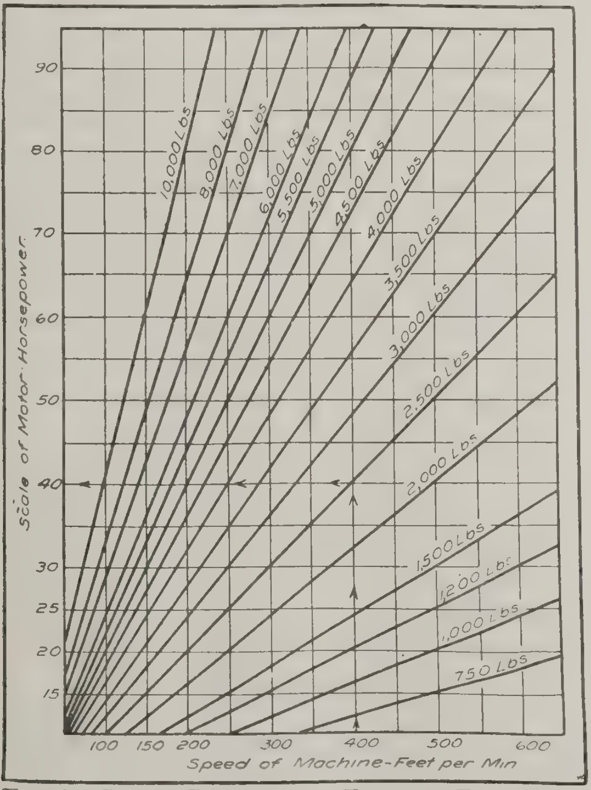


FIG. 1. POWER REQUIRED BY ELECTRIC ELEVATORS.

Corrections: In the table published with Section 1 of this article (page 166 of April issue), the third heading under costs should read "Dollars per Car per Annum" instead of "Dollars per Car Mile per Annum." On page 208 of the May issue, formula (2) should read, $f = (0.5\,n + 2)$, changing the z to 2. It would be advisable for those who desire to preserve these data to enter the corrections on their copies.—Ed.

Electric Trade in Scotland.

According to Consul J. N. McCann, in a recent issue of *Daily Consular and Trade Reports,* the electrical goods and supplies imported into Scotland cover a very wide range. They come from Germany, the United States, Switzerland, France, Italy and Denmark. Germany exports to Scotland all classes of such goods, from a turbine generator complete to an ordinary metal-filament lamp. Arc lamps used are mostly made by home companies, but many come from Germany. The most popular arc lamp on the market is the Johnson-Philip flame arc lamp. Its price is about $50 and it has a good sale. The General Electric Co. has recently introduced a lamp to compete with this. Nearly all the electrical companies make their own lamps. The greatest demand is said to be for the General Electric Co.'s Osram lamp. A good many of the lamps come from Germany. An association of lamp manufacturers is said to control prices.

Vacuum cleaners used here are made in Great Britain or imported from the United States, Germany, or Denmark. There is a big sale for both British and American machines in this district. The Danish cleaner also enjoys a high reputation, but costs more, the price being about $100 to $120.

There is a big field in Glasgow for electric signs, but so far this class of business has not made much progress. Some have been brought from the United States and there are a lot of homemade ones which are very clumsy and are not artistic.

Characteristics of A. C. Circuits.

BY A. H. TIMMERMAN.

Section 3. Current and Voltage Relations in 3-Phase Circuits.

THE distribution of currents and electromotive forces in delta, star, open delta and T connections is of prime importance, for a correct understanding of power distribution in the various parts of a polyphase circuit.

Without going into the question at present of the derivation of the equation, we may say that the power in watts in each leg of a 3-phase circuit is equal to

$$P_1 = \frac{\text{Volts} \times \text{Amperes}}{1.73} \times \text{Power Factor}$$

and the total power in the three legs of the circuit

$$P = 3 \frac{\text{Volts} \times \text{Amperes}}{1.73} \times \text{Power Factor}$$

$$= 1.73 \times \text{Volts} \times \text{Amperes} \times \text{Power Factor. Also}$$

$$\text{Power Factor} = \frac{\text{Watts (Total)}}{1.73 \times \text{Volts} \times \text{Amperes (of each phase)}}.$$

Similarly the power in the two phase circuit is equal to, for each phase

$P_1 = \text{Volts} \times \text{Amperes} \times \text{Power Factor}$, and for both phases

$$P = 2 \times \text{Volts} \times \text{Amperes} \times \text{Power Factor. Also}$$

$$\text{Power Factor} = \frac{\text{Watts (Total)}}{2 \times \text{Volts} \times \text{Amperes}}$$

An examination of Fig. 18 will aid in the correct understanding of the electromotive force relations in the various parts of a delta connected system. Fig. 18-a shows a 3-phase circuit carrying 100 amperes per line and 100 volts across each pair of lines. The windings A C, C B and B A may be taken to represent any generating or receiving circuit. They may represent the primaries or secondaries of a set of either step-up or step-down transformers, the windings of a delta connected motor or of a generator. Under such conditions the electromotive force across the terminals of each winding, such as A to C, must be the same as the electromotive force between two line wires, or 100 volts. These three electromotive forces are 120 degrees apart, as shown in Fig. 18-b. In any balanced polyphase system, the voltages must be in such a direction that the third is equal and opposite to the sum of the other two. This must be true, otherwise there would be an unbalanced condition in the circuit, and currents would flow through the three windings A C, C B and B A even when the circuit is not loaded.

As to the current distribution in the delta connected system, a study of Fig. 19 (A) will aid in the correct understanding of the relations which exist. For simplicity let us suppose that the delta connection represents the secondaries of three transformers which are used for three single phase distribution circuits. The current through each transformer secondary must be 120 degrees removed in phase from the current in either of the other transformers. Let us consider the transformer secondaries C B and B A. The current entering C B at C is 120 degrees removed from the current entering B A at B. The current leaving C B at B is 180 degrees removed from the current entering C B at C; therefore, the currents leaving C B at B and entering B A at B must be 180 minus 120, or 60 degrees apart. This relation is shown in Fig. 19 (B), in which B C represents the current in the transformer B C, B A the current in the transformer B A, and B D the current, in direction and magnitude, in the line B D at the junction of the two transformers.

With two equal currents at an angle of 60 degrees the resultant current must be equal to twice the current in each branch, multiplied by the cosine of 30 degrees, or the current through either B C or B A equals 100 divided by twice the cosine of 30 degrees equals 57.7 amperes. This shows that the current in each branch of a delta connected circuit is equal to the line current divided by 1.73.

The power in each transformer must therefore equal

$$P_1 = 57.7 \times 100$$

and the power in the three circuits or three transformers

$$P = 3 \times 57.7 \times 100 = 17{,}310$$
$$= 1.73 \times 100 \times 100 = 17{,}310$$

In other words, the total power of a delta connected system is equal to the line amperes multiplied by the line volts times 1.73. This is shown in Fig. 20, in which the distribution of currents, electromotive forces and power in the three phase delta connected system is clearly shown.

Referring now to the star connected system as shown in Fig. 21, we have again a voltage between lines of 100, and a current of 100 amperes in each leg of the circuit. In this system each winding must carry the full line current. We have, therefore, the peculiar condition of 3 currents, each of 100 amperes, meeting at the point D. In other words, the resultant of two currents of 100 amperes each, is a third current of 100 amperes. This is readily explained by the diagram in Fig. 21 (B), which shows the resultant of two currents of 100 amperes 120 degrees apart, is a third current of 100 amperes in phase 60 degrees from either of the

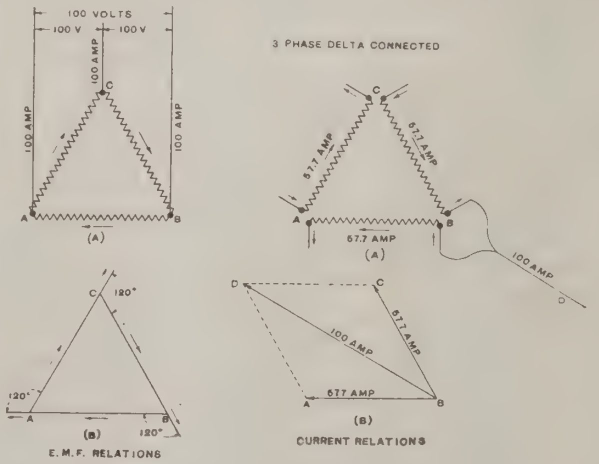
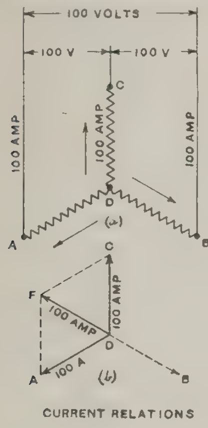


Fig. 18. Voltage Relations in Delta Connected System. Fig. 19. Current Relations in Delta Connected System.

component currents. Therefore, the current in the winding D-B must be opposite in direction to the resultant of the currents in D C and D A.

The electromotive force relations in a star connected system are similar to the current relations in the delta connected system. Referring to Fig. 22 (A) the directions of the voltages at any instant of time in C D, D A and in the circuit connected across A C must be as indicated by the arrows. The electromotive force between C and D is 120 degrees removed from the electromotive force between A and D. The electromotive force, however, between D and C is only 60 degrees removed from the electromotive force between D and A, as shown by diagram in Fig. 22 (B). With the resultant E. M. F. across A C equal to 100, each of the component voltages in A D and D C must be equal to 100 divided by the $\sqrt{3}$ or 57.7 volts.



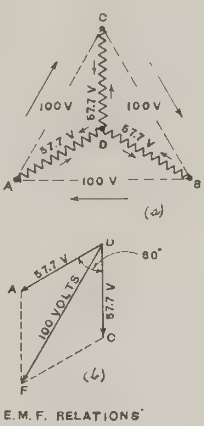


FIG. 21. CURRENT RELATIONS IN STAR CONNECTED SYSTEM.

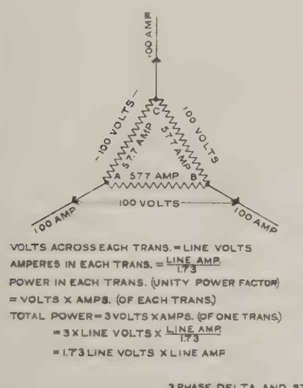
FIG. 22. VOLTAGE RELATIONS IN STAR CONNECTED SYSTEM.

We may sum up then the current and electromotive force relations in the star connected system as follows: The current through each leg of the star winding is equal to the line current. The voltage across each leg is equal to line voltage divided by 1.73. The power in each winding of the star connected system is, therefore,

$$P_1 = (\text{Line Voltage} \times \text{Line Current}) \div 1.73$$

and the total power in the three legs of the star connected system is equal to

$$P_3 = (3 \times \text{Line Current} \times \text{Line Voltage}) \div 1.73$$
$$= 1.73 \text{ Line Current} \times \text{Line Voltage}.$$


100 AMP
C
100 VOLTS
100 VOLTS
57.7 AMP
57.7 AMP
A 577 AMP B
100 VOLTS
100 AMP
100 AMP
VOLTS ACROSS EACH TRANS. = LINE VOLTS
AMPERES IN EACH TRANS. = LINE AMP. / 1.73
POWER IN EACH TRANS. (UNITY POWER FACTOR)
= VOLTS X AMPS. (OF EACH TRANS.)
TOTAL POWER = 3 VOLTS X AMPS. (OF ONE TRANS.)
= 3 X LINE VOLTS X LINE AMP. / 1.73
= 1.73 LINE VOLTS X LINE AMP

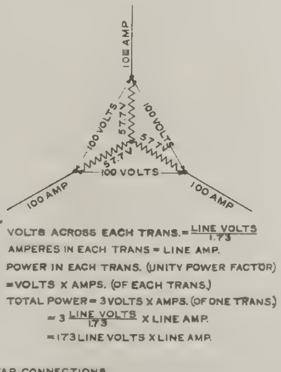

100 AMP
100 VOLTS
100 VOLTS
57.7 V
57.7 V
57.7 V
100 VOLTS
100 AMP
100 AMP
VOLTS ACROSS EACH TRANS. = LINE VOLTS / 1.73
AMPERES IN EACH TRANS = LINE AMP.
POWER IN EACH TRANS. (UNITY POWER FACTOR)
= VOLTS X AMPS. (OF EACH TRANS.)
TOTAL POWER = 3 VOLTS X AMPS. (OF ONE TRANS.)
= 3 LINE VOLTS / 1.73 X LINE AMP.
= 173 LINE VOLTS X LINE AMP.
3 PHASE DELTA AND STAR CONNECTIONS
CURRENT E.M.F. AND POWER RELATIONS

FIG. 20. CURRENTS, VOLTAGES AND POWER IN 3-PHASE DELTA CONNECTED SYSTEM.

FIG. 23. CURRENT AND VOLTAGE RELATIONS IN STAR CONNECTED SYSTEM.

We see, therefore, that the total power in a circuit in which the generating or translating devices are star or delta connected, must be equal to 1.73 times the line volts, times the line amperes.

So far we have limited our discussion of currents and power in delta, and star connected systems to circuits having unity power factor. If the power factor is less than unity, the corresponding power in the different branches of the circuits will be equal to the figures given above multiplied by the power factor of the circuit. To transmit a given amount of power in either a delta or star connected system, the currents through the various branches of the circuit will be equal to the figures obtained for unity power factor divided by the power factor for the circuit.

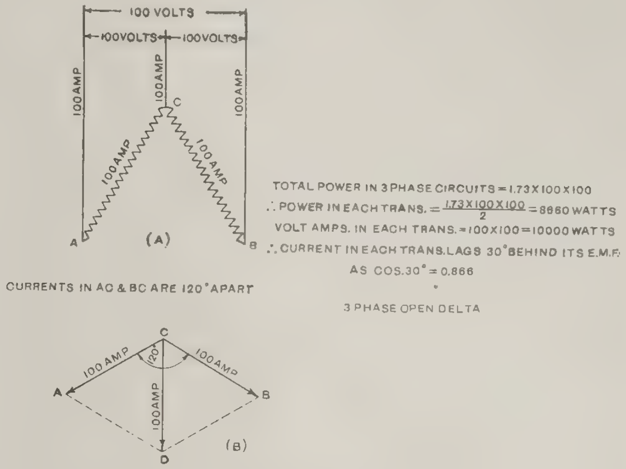

100 VOLTS
100 VOLTS
100 VOLTS
100 AMP
100 AMP
100 AMP
C
100 AMP
100 AMP
A
(A)
B
CURRENTS IN AC & BC ARE 120° APART
TOTAL POWER IN 3 PHASE CIRCUITS = 1.73 X 100 X 100
∴ POWER IN EACH TRANS. = 1.73 X 100 X 100 / 2 = 8660 WATTS
VOLT AMPS. IN EACH TRANS. = 100 X 100 = 10000 WATTS
∴ CURRENT IN EACH TRANS. LAGS 30° BEHIND ITS E.M.F.
AS COS. 30° = 0.866
3 PHASE OPEN DELTA
C
100 AMP
120°
100 AMP
A
B
100 AMP
(B)
D

FIG. 24. VOLTAGE AND CURRENT RELATIONS IN OPEN DELTA SYSTEM.

Fig. 23 shows clearly the relations existing between the currents and electromotive forces, and the generating or translating devices of a 3-phase star connected system.

Next we come naturally to what we term the open delta system of distribution, which possesses some of the characteristics of the star and some of the delta connected system. A diagram of the electromotive force relations of this system is shown in Fig. 24.

A glance at the diagram Fig. 24 (A), shows that the currents through each winding must be the same as the current in the line, and the electromotive force across each winding, the same as that between any two lines. Here also we have a peculiar condition of two transformers connected at C, each carrying 100 amperes, and having a resultant current in the line leading from the point of connection of 100 amperes. This condition is explained by the fact that the two currents are 120 degrees apart in phase so that the resultant current has the same value as either of the components. This is shown diagrammatically in Fig. 24 (B). The above relation can only exist providing the current in each transformer lags 30 degrees behind the electromotive force across its terminals. The transformers so connected have, therefore, a capacity of only 86.6 per cent of the same transformers when used in a closed delta combination. As a result the transformers used in open delta must have a capacity of 15½ per cent in excess of the actual Kva requirements, or what is the same thing, 15½ per cent in excess of the Kw requirements at unity power factor.

If three transformers are used in closed delta, and one is removed, the remaining two will have a total capacity of 57.7 per cent of the three transformers, and if they are required to carry the full load of three transformers, each will be 73.2 per cent overloaded.

One more combination in quite general use is what is called the T connection, for changing from 2-phase to 3-phase, or the reverse. This combination is shown in Fig. 25. Again assuming that on the 3-phase side of the transmission we have 100 amperes in each line and 100 volts across each pair of lines, we see readily that each transformer must have a winding which is capable of carrying 100 amperes, with a difference of potential across its terminals of 100 volts. The total power in a 3-phase circuit is as found previously—equal to 1.73 times line volts, times line amperes, making a total power of 17,320 watts for the two T connected transformers. As the transformer A C is connected for 86.6 volts, the total watts furnished by it will be equal to 8660. This leaves 8660 watts to be furnished by the transformer D H. The current of the transformer D H must, therefore, lag behind its electromotive force by 30 degrees. As each transformer has a capacity of 100 times 100 or 10,000 watts, it follows that to transform from 3 to 2, or from 2 to 3-phase with two transformers T connected, requires the transformer capacity installed to be 15.5 per cent in excess of the actual load, providing the power factor is unity. With a lower power factor a corresponding increase in capacity must of course be made.

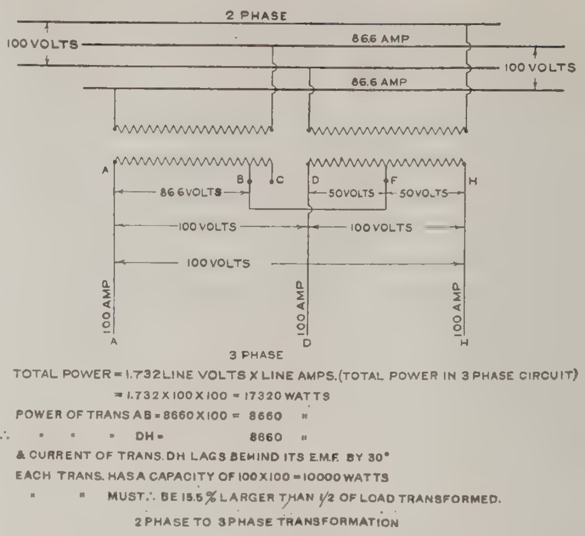

2 PHASE
100 VOLTS
86.6 AMP
100 VOLTS
86.6 AMP
A
B
C
D
F
H
86.6 VOLTS
50 VOLTS
50 VOLTS
100 VOLTS
100 VOLTS
100 VOLTS
100 AMP
100 AMP
100 AMP
A
D
H
3 PHASE
TOTAL POWER = 1.732 LINE VOLTS X LINE AMPS. (TOTAL POWER IN 3 PHASE CIRCUIT)
= 1.732 X 100 X 100 = 17320 WATTS
POWER OF TRANS AB = 8660 X 100 = 8660 "
∴ " " " DH = 8660 "
& CURRENT OF TRANS. DH LAGS BEHIND ITS E.M.F. BY 30°
EACH TRANS. HAS A CAPACITY OF 100 X 100 = 10000 WATTS
" " MUST ∴ BE 15.5% LARGER THAN 1/2 OF LOAD TRANSFORMED.
2 PHASE TO 3 PHASE TRANSFORMATION

Fig. 25. Voltage and Current Relations in T Connected System.

A glance at the 2-phase side of the transformation shows four lines, two for each phase, with a difference of potential of 100 volts per phase and 86.6 amperes flowing through each line. The transformers are, therefore, handling on the 2-phase side only 86.6 per cent of their current capacity. For this reason the total overload on each of the two transformers, when we take into consideration both iron and copper losses, is only slightly in excess of the actual Kva. requirements, and two 50 Kw. transformers can usually be installed to take care of a 100 Kw. load without danger of excessive heating.

Quite a number of schemes have been suggested for 2 to 3-phase transformation. They are all based, however, on the same principles of utilizing voltages in different phases to produce resulting voltages in other phases, and a discussion of each one of these would be of little value.

The Selection, Care and Operation of Carbon Brushes

BY E. H. MARTINDALE, E. E., MEMBER A. I. E. E.

Section 2. A Discussion of Sparking at Commutator Brushes and Local Short Circuit Currents.

Aside from the sparking caused by too weak brush pressure, which was dealt with in Section 1, of the May issue, practically all cases of chronic sparking are caused by one of five things: (1) Incorrect spacing of brushes. (2) Unequal air gaps or defective fields. (3) Brushes not operating at the electrical neutral. (4) Incorrect thickness of brushes. (5) Using brushes with wrong characteristics. It will be seen at a glance that all except the last of these cause abnormal short circuit currents either under the face of each brush or between two or more studs of the same polarity. What follows then becomes primarily a study of local short circuit currents.

We have given the causes of sparking in the order in which we would check up the machine if we were to have only one opportunity to correct the trouble. Before starting an investigation we must eliminate the question of high mica. If the commutator runs nearly true, we can stone the commutator enough to grind the mica even with the bars. If, however, the commutator is not true, or if there are any flat bars, we must turn or grind the commutator before looking for the seat of the trouble.

By spacing of brushes we refer to the distance between brushes on adjacent studs measured around the commutator. Thus, in a four-pole machine the brushes on each stud should be at a distance exactly one-fourth the circumference from the brushes on the adjacent studs. This may be checked up by counting the total number of commutator bars, then dividing by the number of poles, and setting the brushes that number of bars apart. A better way, however, is to obtain a piece of wrapping paper of the same length as the circumference of the commutator and of the same width as the commutator. On this space off the correct distances and draw lines across the width of the paper. Replace this on the commutator, and with one set of brushes set so as to toe one mark, set the brushes on all the other studs exactly on their respective marks. If, then, the sparking cannot be entirely eliminated by shifting the brush yoke either forward or backward, examine the field coils and air gaps. As the field coils on the machine are usually in series, a part of one coil may become short-circuited without becoming apparent except by test. Obtain a voltmeter with a suitable scale and test the voltage drop across each coil. The drop should be the same for each field. If one coil has a higher drop than the others, the coil has been incorrectly wound. If one coil is lower than the other, the coil is either incorrectly wound or a portion of it has become short-circuited; either case will require a new coil.

Another more common defect occurs in compound machines when one of the series fields is reversed. For this we should have a compass. When making this test it is well to check the shunt as well as the series coil. First pass current through the shunt coils; next, bring the compass near one coil; mark it either South or North, depending on which end of the needle is attracted to the field pole. If the bearings of the compass are not perfectly free, use care not to bring the needle suddenly too close to the pole, as it is easy to reverse the magnetism in the needles of moderate-priced compasses. After marking one pole, proceed around the machine when the needle should reverse direction at each pole. If two adjacent poles are found to attract the same end of the needle, one coil is reversed. After all the shunt fields have been tested, current from some source should be passed through the series fields only, care being taken to see that this current flows in the same direction as when the machine is in operation. Nearly all compound machines are cumulative compound, in which case each series field should attract the same end of the needle as the shunt field attracts. The differential compound winding is used only when it is desired to have a rise of speed with an increase of load, and is not in extensive use. In such machines, however, the series fields produce poles of opposite polarity to those produced by the shunt fields.

Unequal air gaps may be the cause of serious trouble, particularly in "lap" or "parallel wound" machines. The unequal air gaps may be caused by poor centering of the armature when the machine was assembled, or may result later from worn bearings. The wear may be either at the bottom of the bearings, due to the weight of the armature, or on a belt-connected machine, at the side of the machine, due to the pull of the belt. This may be checked mechanically by measurement with thin sheets of metal or fiber. For lap wound machines a more accurate method, however, is to disconnect the bus bars or leads which connect the studs of the same polarity. Then, without any load on the machine, each stud will be independent, and with a low reading voltmeter any difference between the voltage generated under the various poles can be detected. Thisis valuable on a lap wound machine, but on a wave wound machine the variations are equalized and the mechanical method is more reliable.

After we have correctly spaced the brushes, checked the drop across the field coils, the polarity of the field poles and the uniformity of the air gaps, we should then be able to shift the brushes to a point where the brushes will not spark with a steady load on the machine.

If the sparking reappears with a variation in load, either the brushes are of incorrect thickness or the neutral field—that is, the distance between adjacent pole tips—is too small. The best way to investigate this sparking is with a voltmeter reading about 5 volts. Take two ordinary lead pencils and trim down one side of each pencil as much as possible without exposing the lead. Near the top of each pencil cut deep enough to expose the lead and attach a piece of lamp cord or other flexible wire to each pencil. Remove one brush and hold the pencils in the brush holder with the points on the commutator and the flat side of one pencil against the front edge of the brush holder and the flat side of the other pencil against the back edge of the holder. This will give us the voltage generated across the brush, or, in other words, the "commutation voltage." Now shift the brushes to a point where they do not spark; read the "commutation voltage." Increase the load until the brushes spark; again read the "commutation voltage." If it has decreased, the brushes are too narrow—that is, the period of commutation is too brief. The remedy is to use thicker brushes or to shift the brushes with each change of load. This condition, however, seldom obtains, and the chances are 100 to 1 that the voltage will increase.

An increase in the commutation voltage indicates that the brushes are too thick—that is, they span too many bars or the neutral field is too small. This thickness of the brushes may easily be changed by cutting down the face of the brush with a hack saw or file, leaving the body of the brush of the proper size to fit the brush holders. This will help the trouble, and if the sparking does not entirely cease, it may be necessary to widen the neutral field by increasing the distance between adjacent pole pieces. We can do this by filing the edges of the pole faces.

We can obtain an idea of the magnitude of short circuit currents from the following test which was conducted recently in the brush laboratory of the National Carbon Company. The test was made on a General Electric, type M. P. 250 volt, 400 ampere, 600 R. P. M., 6 pole, shunt wound generator. On one positive stud, which we will call stud (A), brushes were set three-fourths of an inch ahead of the current position. The other positive studs (B) and (C) were left in their correct positions. The bus bar connecting the positive studs had been calibrated to enable the determining of current flowing by means of a milli-voltmeter. With the brushes incorrectly spaced, but set as near the neutral point as possible, the short circuit current was not excessive. When, however, the brush yokes were shifted only two bars away from the neutral point, the short circuit current out of stud (A) rose to 800 amperes, 400 flowing into stud (B) and 400 into stud (C).

This current, while double the full load capacity of the generator, did not mean much loss in power, as the voltage behind this short circuit current was small. The serious effect of this excessive current on the brushes and heating of the commutator can be seen at a glance. Each stud carried three brushes 1¼ inches wide and 1 inch thick, making a total of 3¾ square inches. Therefore the current density in the brushes without any load on the machine, and due entirely to the short circuit current, was over 200 amperes per square inch on stud (A) and over 100 amperes per square inch on studs (B) and (C). The sparking was severe, the commutator soon became overheated, and the brushes were badly burned and pitted. This is an extreme case, but a much smaller variation in spacing will often produce very serious results.

If none of these remedies cure the trouble, the machine is being operated with brushes not at all adapted to the service. The next step should be to give a manufacturer full details regarding the machine and ask for recommendation of a brush best adapted to the machine and service, since carbon brush manufacturers maintain an engineering department capable to give valuable advice along this line.

The next section of this article will take up a consideration of commutator slotting.

Features of Single-Phase Electric Traction

BY W. H. EDMUNDS.

A Discussion of the Electric, Mechanical and Operating Features of Single-Phase Systems.

INASMUCH as single-phase electric railway systems are as yet about ten years old and rapidly growing in favor among electric traction engineers as against the direct current system with forty years of evolution to its credit, the claims made for the former system are of growing interest. In what follows some details of a single-phase railway system now in operation by the Denver & Interurban Railroad Company are presented as described by Mr. W. H. Edmunds, of this company, at a recent meeting of the Denver Tramway Section of the American Electric Railway Association at Denver, Col. The author is familiar with electric railway practice both in America and in Europe, and what he has to say of foreign practice lends particular interest to this discussion.

The system that is taken up here consists of about 47 miles of line "star connected," or, in other words, three branches of nearly equal length running together at the feed-in-point fro mthe power house, two of the branches of which have their upper ends connected together by a short direct current section two miles long. The overhead line is of single catenary construction, rigid type, having 7/16-inch high strength steel messenger cable and 4/0 phono-electric contact wire, which is about equal to 2/0 hard drawn copper in current capacity. There is no feeder wire on the alternating current section, although the Denver end is 20½ miles from the power house, and high speed passenger trains of 325 tons are started and accelerated upon a 3 per cent grade at the very end. The overhead lines are sectionalized every five or six miles by pole type switches to facilitate repairs in case of line trouble.

The power house contains two 1,500 Kw., 3-phase, 11,000 volt generators, two phases of the windings of each being connected up to give single-phase current, and which gives the generators a rating of about 1,000 Kw. running single phase. One of these is operated for usual service, both being required only on days when there are several extra cars on the line.

The current, generated at 11,000 volts, is taken through an oil switch direct to switchboard bus bars, from whence it is distributed through two oil switches to feed in lines which run to the middle point of the road mentioned, where the three lines meet, and where, by suitable pole top type switches, either or both of the feed in lines can be made to energize any one, two or all three of the railway lines. Tests made in 1909 having voltmeter at Denver and two cars just beyond voltmeter, starting simultaneously with a third car on the same section, gave a voltage fluctuation of 2,600 volts. In other words, starting 160 tons of high speed equipment 20 miles from the power house with but a 2/0 current conductor, and having only a 25 per cent drop, illustrates the efficiency of the system.

The rolling stock and equipment is as follows: Eight motor cars, 55½ feet long, 10 feet and ½ inch wide, weighing 60 tons, six being straight two-compartment passenger cars seating 59, two being three-compartment combination passenger and baggage, seating 54; four straight passenger trailers, weighing 33½ tons, seating 60, and two converted railway coaches. The motor cars are equipped with four 125 horsepower type 148-A Westinghouse single-phase motors; gear ratio, 25—66, mounted in American locomotive trucks having 37½-inch wheels. The equipment also includes Type AMM high speed brake schedule and all necessary apparatus for hand-controlled, battery-operated, unit switch control, so arranged that one or any number of cars can be operated in one train by one motorman. This will be described in detail later.

Current is taken from the conducting wire through an air-operated pantograph collector having a sliding contact shoe four feet long and made of No. 16 galvanized iron. These shoes cost about one-third as much as the standard 6-inch wheel, and run about 15,000 miles before being scrapped. The pantograph trolley is controlled by two push buttons located in under side of master controller in cab. The pantograph is held up normally by a spring located in the cylinder which gives a pressure of 12 pounds between shoe and wire. It is lowered by means of the push button mentioned energizing electro-pneumatic valves which admit air at 85 pounds into the cylinder.

Current from the trolley is taken through suitably insulated cable to an oil switch with overload trip attachment. This corresponds to the "overhead" on direct current cars. In case of this circuit breaker opening, it is reset electrically from the master controller. From the circuit breaker the 11,000 volt current is led to a 250 Kw. oil insulated auto transformer which has ten low voltage taps, the highest being 636 volts and the lowest having 106 volts. This lowest voltage is used for lighting and for operating the small motor generator set used in recharging control battery. One of 300 volts is used for air compressor motor, and the other eight are led to a group of eight switches for motor control.

In direct current work it is necessary to lower the line voltage very considerably when starting, and this is done by means of resistance, the current so used being thrown away in the shape of useless heat. Alternating current furnishes the most efficient method of motor control yet known, as the current is reduced to the proper amount in the auto transformer with but very little loss and carried to the motors in increasing voltages by means of the different transformer taps connected to the proper switches. When controller handle is placed upon first notch for running car, four switches of the eight in the motor control group come in successively, the first giving voltage barely enough to take the slack out of the gearing, each of the other three being progressively higher and of sufficient combined voltage to start a car on level track. As these different voltages all come from the same transformer and are connected together, some means must be taken to prevent a short circuit and consequent great rush of current between transformer sections. Consequently, before these four different voltage leads are connected together where leading to motor feed switches, they are passed through three balance coils so arranged that suitable resistance is furnished between each transformer section, and also that the four different voltages are added and balanced. In applying the next higher voltage by means of the second controller point, all of these four switches now in are not opened, but the one having the lowest voltage drops out and one giving the next higher voltage than any of the first four takes its place and is balanced as at first. By this means only one-fourth of the current is interrupted at each controller position, this being similar to the bridging method in direct current practice.

From the motor feed switches current is led direct to motors and thence to ground. By this means all of the main motor current is handled beneath cars away from passengers and crew, the only current used by motorman being 14 volt battery current. On direct current the same equipment is used, except that resistance replaces the transformer and balance coils. Running on direct current section, the motors are connected in full series, fields and armatures. On alternating current they are in series-parallel, all fields being in parallel, the armatures of each truck in series, and the two truck groups in parallel. This same arrangement is used on the 7½ horsepower motor for air compressor, which operates on 400 volts direct current with fields and armature in series, and on 300 volt alternating current with fields in parallel, but in series with armature.

On alternating current no lightning protection is used beyond ground wire of line construction and transformer. On direct current a multipath 1,000 volt arrester is used. This serves equally well for lightning or an entanglement of the low voltage trolley with the 11,000 volt circuit. On account of 600 volt direct current work, lighting and heating circuits are arranged for 600 volt series connections, both alternating and direct. With alternating current alone this would be arranged for 110 and multiple work and much simplified.

A few words regarding the motor windings may be interesting. The armatures are the ordinary strap wound series type, practically similar to direct current type, except having a length of resistance metal connected in series between each commutator segment and main coil. This is to prevent the transformer action of coils when an alternating current and two or more coils are short-circuited by the brushes.

The fields are four pole with main fields having six turns of 1¼ x ¼ inch copper bar, while distributed through the face of the fields is what is called the auxiliary winding also of copper bars, ¼ x 1¼ inches, in series with, but in magnetic opposition to, the armature current, its purpose being to neutralize the self-induction of the armature when excited by alternating current fields.

The control system is the well-known electro-pneumatic type, having switches actuated by compressed air, which is admitted to and exhausted from switch pistons through small electro-magnet valves, these in turn being controlled by a small drum controller having 12 wires and using a 14 volt storage battery for energizing these magnets. These same 12 control wires also extend from end to end of each car, so that when several cars may be coupled and these control wires are connected by a suitable jumper, a motorman in any car energizing these control wires by means of the controller will cause the similar switches on each to act simultaneously, thus operating all of the cars as a unit.

In running from one current to the other, either alternating or direct, the change of switch operation is semi-automatic. For reasons of safety, the 550 volt trolley not being insulated for 11,000 volts, this must be raised and lowered by hand, while the 11,000 volt trolley, as stated, is operated by push button control. Connected direct to the 550 volt line and through the 300 volt connection on the alternating current side are two small relays operating contact discs. When either trolley is raised when under proper current section and its relay energized, connection from the 14 volt battery is made to one of two electro-pneumatic valves governing a so-called change-over switch. This energizing of valve causes the change-over switch to assume a position corresponding to the current being used, the switch then connecting the 12 control wires to the proper switch magnet valves to give series or series-parallel operation of motors as necessary. This same movement of change-over switch changes connections of air compressor motor as well as heating and lighting circuits.

If single phase alone be used, this allows the car equipment to be made very simple and easily understood. The dual system of alternating and direct current, however, requires more equipment with complications of wiring and control than is consistent with good operation, though its record will compare favorably with many of the best direct current roads.

The newer equipment of the single phase type is very rugged and dependable, capable of withstanding very severe usage and abuse while still giving excellent wearing qualities in all parts. Its application cannot be made by rule of thumb, however, but should be the result of careful study, considering financial, operating and engineering conditions.

EUROPEAN ELECTRIC RAILWAY OPERATION.

In Italy the three-phase and single-phase systems are given preference, mainly on the Italian state railways, and have some features very much different from the system so used in this country. The Italian state railways prefer the three-phase system for operation in the mountains and over heavy grades, where stops are not frequent and loads constant. Such operation is particularly suited for three-phase work and is operating very successfully. The induction type of motor which has no commutator is used on these locomotives. On account of these characteristics, the motor upkeep is very low and the maintenance very satisfactory. Also, on account of these motors having constant speed characteristics and high losses in work requiring frequent acceleration, they should only be used under conditions as given above. In their overhead construction for this three-phase work they use, of course, two trolley wires of different potential and insulated from each other, the rails being used for return current of the other phase. They also use some single phase in Italy, which has proven very successful. Preference seems to run from 12,000 to 15,000 volts overhead, with a frequency of 15 cycles.

I might state here that this difference between Europe and this country is very marked. The motors we use, which are standard in this country, are designed for 25 cycle. This was adopted chiefly because the systems of power generation here are usually 25 cycle and 60 cycle alternating current. Owing to this construction, it was considered cheaper to adopt the motors to fit the existing power plants rather than requiring new generating stations for their railroad installation. The motors operate better and cooler on lower frequency than on the 25 cycle system. Our motors are rated at 125 horsepower, 25 cycle. If the frequency of 15 cycles alternating current were used, these motors would be rated at about 15 to 20 per cent higher. In other words, they would give practically the same power without forced ventilation that they now do with forced ventilation.

In Germany they seem to prefer the single-phase system exclusively in alternating current work. The principal motor used at the present time is similar to the Winter-Eichberg type, which has its commutating resistance external to the rotating part. The claim is made for that type that its upkeep is very much lower than its American brother. High voltage direct current is practically in its infancy in Europe on account of all single-phase lines being very successful, and, on account of cheapness of labor, maintenance is very low, offsetting the claim made in this country of high maintenance charges; consequently the application of single phase is very much more favored than in America.

Sweden has several notable installations operating at a frequency of 15 to 16 cycles and 15,000 volts or more working voltage on the trolley. The Swedish railway engineers reported recently in favor of this type and recommended that 1,825 miles of government railroad be equipped exclusively with single-phase of 15 cycles, and in going into this they prepared three statements, giving the initial cost of high voltage direct current, three-phase and single-phase installations and the peculiar characteristics governing each. Their final recommendation was unqualifiedly in favor of single phase.

Important Considerations When Testing Switchboard Instruments.

BY H. A. COZZENS, JR., B. S.

MANY large public utility companies are placing considerable stress on the testing and calibration of plant switchboard indicating instruments. This work is usually placed in the hands of a few specialists employed for this purpose or under the regular routine of a testing or standardizing laboratory. Switchboard indicating instruments, while essential to good plant operation, need not possess the continued accuracy which is required of an integrating meter. The average attendant rarely reads between the scale divisions, and in general uses the instrument as an indicator of the load being on or off and as a rough sign of its magnitude. But regardless of these existing conditions, it is a wise move to annually inspect, clean, and, if possible, check some of the more important of these instruments.

By the more important of these is meant the voltmeters and ammeters on all circuits, with particular attention to those on important feeders. It is natural to assume that all instruments on generator circuits are maintained in the best of condition. The feeder instruments, while perhaps not so important, may be kept in good shape by one or two men, the duty of one being to periodically visit the stations and do routine testing, the other man doing instrument overhauling and repairing while in the laboratory and held in reserve to respond to instrument complaint calls at any power station. Experience will show that it is far better to place such complaints in the hands of an experienced instrument man than to expect station electricians and operators to make the alterations and repairs.

This may seem inconsistent, since the item of expense is high when a man must travel a great distance for a slight repair; but, on the other hand, there is the assurance that the work is done correctly. For instance, cases are common where a rotary converter or a generator flashes over or a surge occurs an dthe ammeter pointer jumps the stop at the end of the scale and gets caught. The operator removes the cover and pushes the pointer back to zero. Since instrument mechanism is more or less delicate, this operator may have changed the balance of the instrument in moving the pointer, or perhaps he has, for fear of breaking the pointer, neglected to straighten it. In cases where astatic ammeters are used, operators persist in placing pointers on zero when the feeder is dead, so that when the load is on and the magnet is energized, the pointer jumps ahead and a false reading results. Unwarranted tampering usually leads to the introduction of friction in the meter, or, as is sometimes the case, the scale must be removed to erase finger prints. These instances are cited to illustrate the numerous possibilities for not only erroneous readings, but also for the introduction of mechanical and electrical defects in instruments.

There is no fast and set rule as to the method of testing these instruments. The voltmeters may be tested by comparison with a portable standard meter placed in multiple with the instrument on the board, and the pointer set at the working point or thereabouts. With ammeters a little more care is exercised. In rough check work the current transformer is short-circuited and the wires removed from the instrument terminals. The instrument is then placed in series with a cluster of lamps and a standard ammeter. After being adjusted for zero, a lamp at a time is thrown in and the points on each instrument recorded. By using

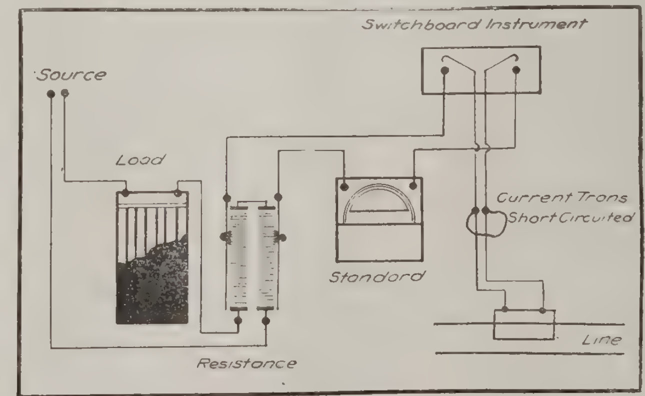


Fig. 1. Arrangements for Testing A. C. Ammeter.

the transformer ratio as a multiplier, the percentage of accuracy may be found by dividing the reading of the switchboard meter by the reading of the standard multiplied by the ratio. In this way it is possible to connect a whole string of ammeters in series and get a rough check on their accuracy. By taking out each lamp in turn, the process may be reversed in going down the scale, and any discrepancy in the resulting readings will be an indication of friction or unbalance in the meter.

When it is desired to obtain a more accurate calibration, a meter-testing load box and a slide wire resistance may be used to advantage. The general scheme for such a test is shown in Fig. 1. The slide wire resistance consists of two coils, is compact in form, and may be used in the testing of both A. C. and D. C. ammeters. The use of this method enables ammeters to be tested at any scale point, and in arc light "tub" stations this scheme is always used to set the meters at the exact working point.

While the tendency now is for a standardization of meters with regard to type and manufacture, there are many cases where a holding company has assimilated numerous smaller concerns, and, as a result, the numerous and diversified types of instruments makes the item of instrument repairs quite costly. The five-ampere secondary ammeter in both the round or horizontal edgewise type seems to be very popular at the present time.

On direct current circuits millivoltmeters with shunts are used to some extent, and at this time, when manufacturers are standardizing shunts, the testing is made comparatively easy. In the older stations it is often necessary to calibrate the shunts before anything can be accomplished with the instrument, as the shunt data has either been lost or unrecorded. This shunt data represents quite a value and should be entered in the instrument inventory in a bound book, from whence it can be copied on filing cards and issued to the repair men. A diagram of the method of testing direct current ammeters is shown in Fig. 2, the dry battery being short-circuited across the slide wire resistance.

With ever-increasing electrical development and the introduction of household appliances, the load on individual feeders is constantly on the increase. This condition calls for a change of current transformers of a greater ratio, and consequently a change of ammeter scales. Where this occurs infrequently it is not much bother, but in a large company the matter of scale alteration is of some importance. Scales mounted on the usual brass back may be purchased from manufacturers, but when scale making is of such volume that it becomes a part of the laboratory routine, a more economical means must be had. Having on hand some hundred or so old scales, the writer decided to utilize these and devised the following scheme: They were cleaned and bristol board cut to fit the scale faces, and the necessary printing placed thereon. Mounting the cardboard on the scales presented some difficulty at first, so a cheap form or press was made at a wood-turning shop. The scale was inserted in this and left to set over night. By this means enough scales are kept on hand to fill the needs. The above refers to instruments having horizontal edgewise scales. The scales for round type instruments are purchased direct from the manufacturer and at a much less cost, since there is no brass plate attached.

Where it is inconvenient to remove the instrument from the switchboard and bring it to the laboratory, another difficulty presented itself. At first the instrument men were given a blank scale and as located when using the new transformer ratio. While it may appear strange, these scales were returned with so many dots that it seemed impossible to have an assurance of any accuracy. This was not due to carelessness on the part of the instrument men but was merely the result of checking up the points two or three times, the width of the pointer being responsible for a slight deviation from the original point. A scale with arbitrary divisions was then supplied to the instrument men divided to read in tenths between the smaller divisions and hence a very accurate reading can be obtained. By the use of this method the placing of points is eliminated as the scale is placed temporarily on the instrument and the resulting reading recorded and checked.

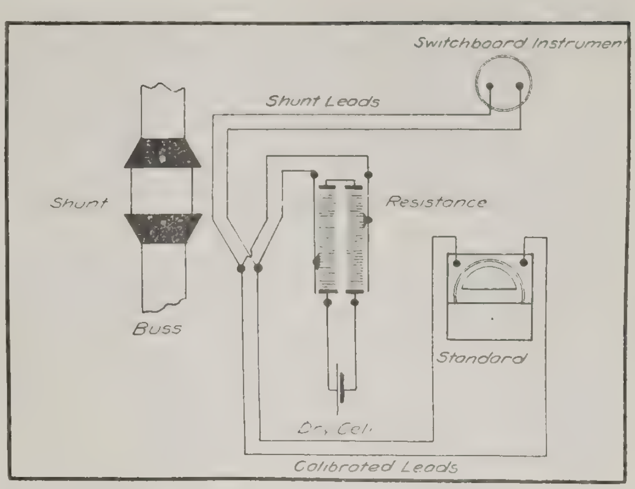


FIG. 2. ARRANGEMENTS FOR TESTING D. C. AMMETER.

Another difficulty encountered when the scale was given to the men directly, was the failure to center the scale. Of course this is now done by the man who draws the scale and he does it from a mathematical standpoint using the readings on the arbitrary scale as a basis where before the centering was done more by eye.

To insure a presentable appearance and also a uniformity a set of numerical type covering the more important points on ammeter scales has been acquired and the use of these and later filling in the numbers with india ink relieves any suspicion that the scales are "homemade."

Convention of Electric Vehicle Association.

Owing to the greatly increased interest generally evident in electric vehicles, and the great volume of work to be disposed of, three days will be allotted to the fifth annual convention of the Electric Vehicle Association, to be held in Philadelphia, Monday, Tuesday and Wednesday, October 19, 20 and 21. Heretofore Electric Vehicle Association conventions have been confined to two days, and it now seems that difficulty will even be experienced in crowding into three days the work of the convention on account of an extensive and far-reaching program. Further details will be published in an early issue of *Electrical Engineering.*

The association is rapidly extending its activities, sections having been recently formed at San Francisco and Cincinnati. Other sections have been organized at Chicago, Philadelphia, Washington and Boston, with others soon to be added.

Lighting Considerations and Results in a Modern Plant

BY A. B. ODAY, ILLUMINATING ENGINEER.

Important Lighting Recommendations for a Modern, Open-Girder, Saw-Tooth Roof Type of Plant.

THE importance of adequate illumination suited to the particular conditions of any important building, both as regards the work to be carried on therein and the structural nature of same, is at the present time receiving proper recognition as a part of the engineering work at the time the structure is planned and before its construction has been finished. As an excellent example of such consideration and the results secured in the shape of daylight facilities and provisions for artificial illumination, the writer calls attention in what follows to the lighting of the new plant of the Gurney Electric Elevator Company at Honesdale, Pa. This illustration is taken because it represents a common type of plant construction, and presents interesting considerations and recommendations that should prove of interest to those who have occasion to make lighting recommendations in factories and mills of similar requirements.

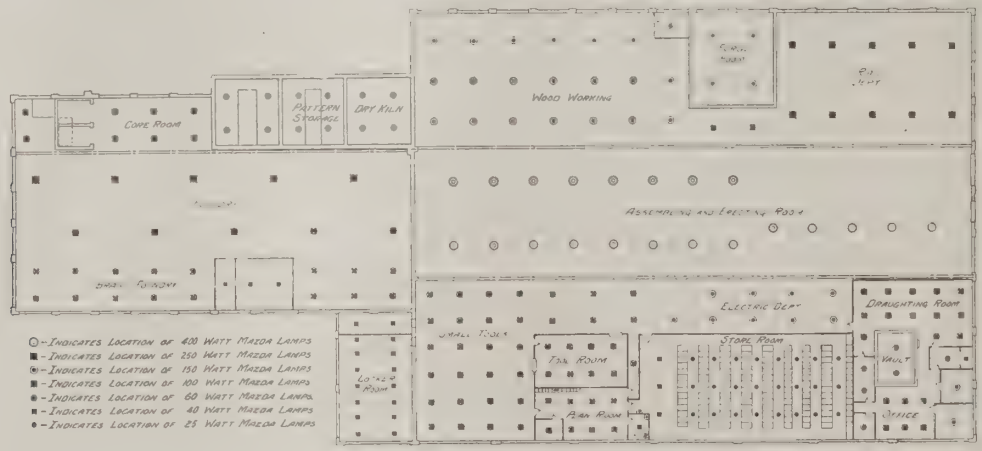

Core Room
Pattern Storage
Dry Kiln
Wood Working
Assembling and Erecting Room
Electric Dept
Draughting Room
Small Tools
Tool Room
Store Room
Vault
Locker Room
Plan Room
Office
○ - Indicates Location of 400 Watt Mazda Lamps
■ - Indicates Location of 250 Watt Mazda Lamps
◉ - Indicates Location of 150 Watt Mazda Lamps
■ - Indicates Location of 100 Watt Mazda Lamps
● - Indicates Location of 60 Watt Mazda Lamps
■ - Indicates Location of 40 Watt Mazda Lamps
● - Indicates Location of 25 Watt Mazda Lamps

Fig. 1. Floor Plan of a Plant, Showing Position and Size of Lighting Units.

As shown in the accompanying illustrations, the side sections of the building are of modern, open girder, saw-tooth roof construction, while the central portion is constructed with large windows on each side, located above the roof of the side sections. The exterior walls of the building are made up of steel window sashes, which are equipped with reinforced diffusing glass. The interior, being painted white, materially assists in making the illumination more effective, as a greater portion of the light which strikes the walls is reflected instead of being absorbed, as is the case in most factories. With this type of construction a close approximation of ideal daylight conditions exists.

The artificial illumination of this plant compares very favorably with that during the daylight period, the installation being designed under the supervision of Mr. G. H. Stickney, of the Edison Lamp Works of the General Electric Company, Harrison, N. J., and installed by the Watson-Flagg Engineering Company, of New York City, due consideration being given to the subject of intensity and direction of light, so as to obtain the best possible results for all classes of service. In Fig. 1 a sketch is shown of the floor plan of the building, giving the location of the various departments and position and size of lighting units which were installed. Fig. 2 shows a section of one of the side bays where small machine work is done. Localized general illumination is supplied in this portion by 100 watt clear tungsten lamps and Holophane D'Olier porcelain enamel, dome type, steel reflectors, known as type (DED-100), hung eight feet above the floor. The units are spaced on about ten-foot centers, making an approximate wattage consumption of one watt per square foot. The illustration clearly indicates the results obtained, showing an absence of glare and shadows, with a relatively high intensity of well distributed light.

One of the most pleasing portions of the building, from the standpoint of good illumination, is the assembling and erecting department. This is located in the center bay, as shown by Fig. 3. Illumination is supplied by 21 400-watt clear tungsten units equipped with Holophane D'Olier porcelain enamel, dome type, steel reflectors of the (RED-500) type. These units are spaced on 15 by 25 foot centers, above the path of the traveling crane, and hung about 20 feet from the floor. There is a wattage consumption of approximately one watt per square foot distributed over this area, with the exception of the shipping department, where the consumption is about half a watt per square foot.

The demand for excellent illumination in the wood-working shop is admirably met by the use of 20 150-watt clear tungsten lamps with Holophane D'Olier porcelain enamel, dome type, steel reflectors of type (DED-150). These units are placed in three rows, spaced on about 12-foot centers. Purely general illumination is used, there being in no case any drop lights for individual machines. The power consumption is about one watt per square foot. Fig. 4 shows a night photograph of this portion of the building.

As most of the moulding in the foundry is done in the

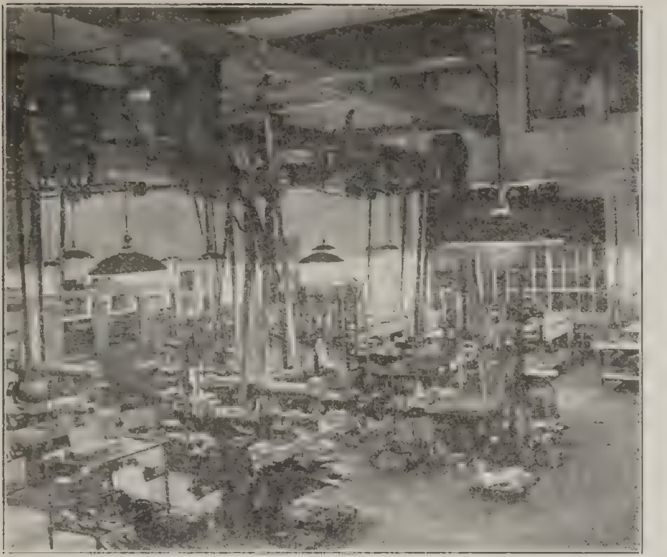


FIG. 2. ILLUMINATION IN THE MACHINE SHOP—ONE WATT PER SQUARE FOOT.

early part of the day, in a room where adequate daylight facilities are available, it is not necessary that there be a high intensity of artificial illumination, as most of the evening work consists of putting the foundry in order. A low intensity of illumination is supplied for this work by 10-250 watt clear tungsten lamps with Holophane D'Olier enamel steel type (DED-250) reflectors. These units are spaced as shown on the plan and hung above the traveling crane. The wattage consumption in the main portion is approximately 0.45 watts per square foot. The side bay, or brass foundry, is lighted by 10-100 watt clear tungstens, also equipped with Holophane D'Olier enamel steel reflectors of the type (DED-100). The consumption in this portion is about 0.75 watts per square foot.

A special room has been built for the storage of patterns. It is constructed in the form of a vault, the only entrance being from the outside. Illumination is supplied by 8-60 watt clear tungsten lamps in Holophane D'Olier reflectors of (DED-60) type, hung nine feet above the floor. The units are placed with respect to the location of the storage racks.

In Fig. 5 a night photograph is shown, giving the illumination obtained in the drafting room. Although this is a comparatively small room, the results show what may be accomplished by an equipment which differs slightly from that used in similar rooms of other installations. Illumination in this room is supplied by 12-100 watt bowl frosted tungsten lamps with Holophane D'Olier enamel steel reflectors of type (DED-100). These units are hung about 10 feet above the floor, thus eliminating the glare which would otherwise be objectionable from the use of this type of reflector. It is interesting to note that, although opaque reflectors are used, the ceiling and side walls are fairly well illuminated. The illustration also shows that there are very few deep shadows. The original specifications recommended that bowl-shaped prismatic glass reflectors and higher wattage lamps be installed in this portion, but, due to the fact that it was possible to locate the drafting tables with reference to the lighting units, the substituted system gives quite satisfactory results.

The various offices throughout the building, and the other departments which are not of sufficient importance to warrant discussion, are lighted in a manner which is in keeping with the departments just described, being equipped in all cases with standard, up-to-date equipment. General

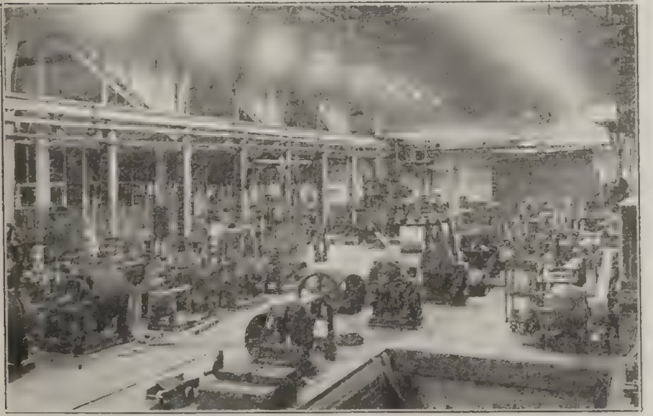


FIG. 3. ILLUMINATION FOR ASSEMBLING AND ERECTING DEPARTMENT—ONE WATT PER SQUARE FOOT.

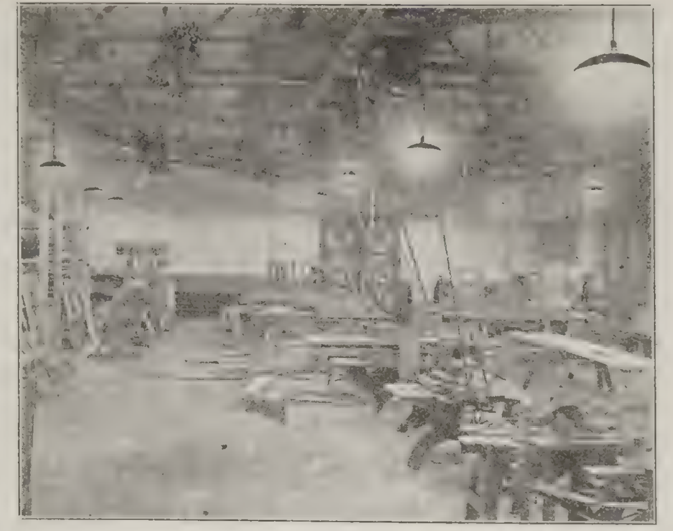


FIG. 4. LIGHTING ARRANGEMENT AND ILLUMINATION FOR WOODWORKING MACHINERY—ONE WATT PER SQ. FT.

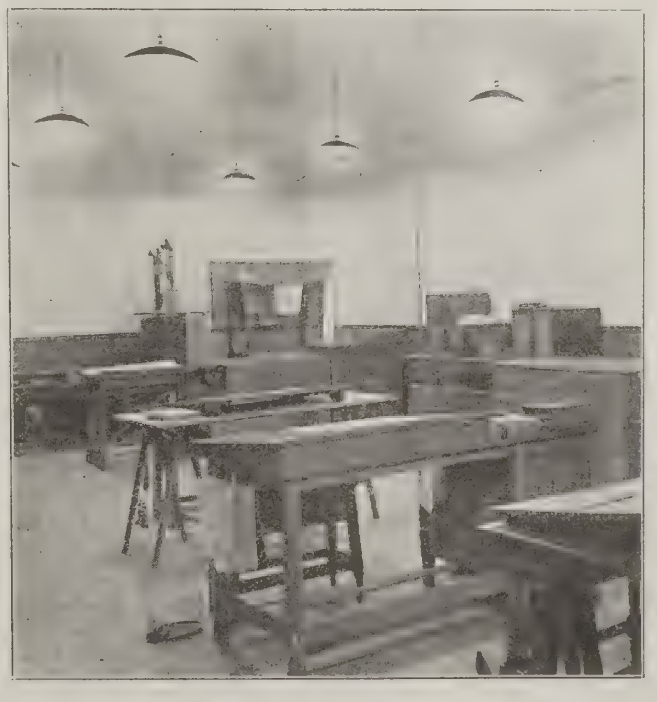


FIG. 5. GOOD ILLUMINATION FOR A DRAFTING ROOM.

illumination is obtained in the offices by the use of 100 watt bowl frosted tungsten lamps with Holophane prismatic Xtraficiency glass reflectors of type (XI-100), hung 9 feet above the floor and placed on 8-foot to 10-foot centers.

This installation is of particular interest, due to the fact that there is no department where localized illumination is used. In the majority of cases strictly general illumination has been adhered to, the only exception being in the machine shop and drafting room, in which cases the machines and benches were located so as to receive the proper direction of light, thereby gaining the effect of localized general illumination. The lighting units are not under the control of the workmen, but are regulated by the superintendent from the main panel box.

An expression of complete satisfaction with this lighting equipment was advanced by the management, who stated that their primary object was not to save money on the first cost of the installation, but rather to secure a lighting system which was thoroughly up-to-date, and from which the best possible illumination could be secured. Without a question, this has been received, and the increased cost will be returned in a manner which is difficult to estimate—namely, in increased efficiency of departments and best possible quality of workmanship under the conditions.

The Status of Regulation of Public Service

BY A. G. RAKESTRAW.

An outline of the Tendencies of Regulation by Commissions and Results to Date.

YESTERDAY regulation of public utilities was a new subject, revolutionary in its character, regarded with suspicion and approved with caution. When we study the history of the movement, the causes leading up to it, and the principles on which it is based it is found, indeed, to be truly revolutionary in its character. Recent advances, so rapid as to be almost startling, are but the culmination of a slow but steady change in public sentiment which has simultaneously expressed itself in legislation over the United States. The resulting laws, while varying in details and in many cases as yet imperfect, agree surprisingly well in fundamental principles.

The first fact apparent from a study of the subject is that there is an essential difference between public service so called, and other lines of business. Any person with sufficient capital may open a store, manufacture goods, or cultivate the earth, for there is no natural monopoly in these or similar lines. However, when a person or corporation undertakes to furnish the community at large with a service or commodity necessary to the public comfort, such as gas, water, electricity or transportation, and such cannot be effected without laying tracks, or pipes, running pole lines, or otherwise making use of the public roads, streets or alleys, at once a natural monopoly exists. By this we mean, that the best interests of both the public and the corporation are served by monopoly, and that competition causes not only interference and dispute over the use of the public right of way, but actually increases the cost of service to the public. This is evident when we consider that two complete distribution systems are required, each one covering the entire territory. Buildings and generating equipment are also in duplicate; superintendence and administrative expense are practically doubled; in short, it is evident that the cost of running two small plants is considerably greater than that of running one plant of twice the size.

The immediate result of competition in most cases has been to temporarily lower the rates with the ultimate result either absorption, or a price agreement. In either case the disadvantages of competition, without the benefit of monopoly are the result. In many cases a price war has continued for several years, with neither company making any money. While the average American citizen does not relish being "gouged," he does invariably recognize the right of those engaged in business to a reasonable profit.

In regard to competition, the Georgia commission gives this opinion: "We do not believe that competition can ever be a consistent and proper regulator of rates and other conditions in the public utility field. Real competition in such a field means duplication of plants, which when once built are generally useless for other purposes. In our opinion, the government which properly assumes to prescribe reasonable rates and compel adequate service by public utilities, should also protect such utilities and the public from unwise or useless competition and the wasteful investment of money in plants that are unnecessary."

Another popular remedy for high rates, real and imaginary, is the municipal plant. Occasionally these have been successful but most frequently dismal failures, for the reason it has seemed almost impossible to keep such enterprises free from politics. Further, there is usually a total disregard for anything like economy either in the construction or the operation of such plants, with the engineering often of the poorest, and the accounting the same

A large New York bond house has the following to say on the subject of municipal plants. "We believe that it is most essential that cities control their own water works. parks, schools, fire and police departments, etc., but believe they are taking an unwise step when they engage in miscellaneous and general business enterprises. We believe that a better service in the long run and a more economical service, will be rendered when these matters are in the hands of private enterprise and capital, with the city having supervisory control. Some of the cities of the country have under way the creation and control of various public utility enterprises, all requiring a very large issue of securities, and as a rule their municipal credit is being largely damaged and their bonds continually seeking a lower level. The credit of the largest corporation, or the largest city or nation can be impaired or destroyed by abuse, and in our judgment if any city enters the public utility field on a very large scale, and backs such undertakings with its public credit, its public credit is bound to receive very great damage and injury."

The first attempts at regulation were by state laws, and city ordinances. A great many of these measures, especially those enacted by borough and city councils, were totally unreasonable, amounting to confiscation. This was due to the fact that the councils, as a rule, were prejudiced and without adequate means of obtaining information. The passage of such laws and ordinances was followed by numerous appeals to the courts, with consequent litigation, expensive alike to the corporation and the municipality and affording but little relief to the public.

Following this came the idea of regulation by a state board of experts, who should act in a judicial capacity, acting for the public with power to correct abuses, adjust rates, prevent discrimination, provide for safety, and at the same time guarantee the corporation a reasonable return on the investment, protect it from competition, exploitation, and confiscatory ordinances. This is the commission system in present use, which has in general proved eminently satisfactory.

It is not our purpose in this article to analyse public service laws and the decisions of the commissions for such a digest would require a volume in itself. It may be said however that some of the laws are strong and well written, while others have points that are weak or obscure. Wisconsin and Indiana are recognized as having especially good laws, and in these states, as in a number of others, municipal plants are subject to just the same regulation as those privately owned, which is just. In most states the commissions have the power to make a physical valuation of the property to determine the reasonable amount or return which should be permitted. The state of Ohio has amended its laws recently to include this feature. Another valuable provision in the Wisconsin law, is that no public utility corporation can begin operations or extend its lines into any locality already served by another corporation without securing from the state commission a certificate of necessity, and this will not be granted except where it appears that such additional service is necessary to adequately supply the public.

Under commission regulation the extension of operations by holding companies or syndicates has received new impetus. Until recently the welfare of the smaller lighting companies was at the mercy of legislation and naturally there was some risk in the acquisition of a large number of properties. Now that the earning power of every central station is assured, the movement of consolidation has gone on apace, with the tendency to lower rates to the consumer instead of raising same. For example, the Middle West Utilities Co. of Illinois has undertaken to supply an immense field formerly served by 79 independent generating stations. These have been reduced to 12 and will ultimately be replaced by four. The most casual study will indicate a considerably lower cost of production than before. Under no regulation, this might not result in a proportionate saving to the consumer, but under state regulation, the only revenue which will go to the corporation will be that which will give a reasonable return on the investment, the balance of the saving going to the pockets of the consumers.

Two other important results have been accomplished by commissions. These are the raising of the standard of service, and the enforcement of safety regulations. Much antiquated and obsolete apparatus has been condemned, new distribution systems ordered, defective insulation remedied, safety appliances furnished to workmen, and other improvements suggested. This has cost a great deal of money, but it has produced results well worth the expenditure.

In a recent address, Hon. Jno. H. Roemer, chairman of the Wisconsin commission, gives some interesting facts relating to the work accomplished in the five years that state regulation has been in force in that state. He describes the advantages of the indeterminate franchise, which by law, is granted to every public utility in Wisconsin. By the terms of such franchise the corporation has a right to do business on its good behavior, as it were, the municipality having the right to take over the physical property at any time by paying a fair valuation therefor. The enforcement of scientific accounting has also been of great benefit to the utilities of the state. Many of them never knew before what service was costing. The municipal plants seem to be among the worst offenders, and the slowest to get into line. The commission employs secret inspectors who travel over the state, making tests and inspecting the general service conditions. The utilities have been at considerable expense in meeting the requirements of the commission, but the latter's engineers estimate that the raising of the standard of service has saved the people of the state about $75,000 per year.

Convention of Mississippi Electrical Association.

The Sixth Annual Convention of the Mississippi Electrical Association, a state section of the National Electric Light Association, was held at Meridian, Miss., April 27th to 29th, attended by some 60 member companies, employes and guests. The convention was opened Monday morning, April 27th, with an address of welcome delivered by Hon. W. E. Baskin of the Meridian Light & Railway Company. After appropriate remarks of greeting, Mr. Baskin reviewed briefly the application of electrical energy from the layman's standpoint, urging that the hazard to life and property in connection with transmission and application of electrical energy be given sufficient study to minimize the danger to all. Mr. Baskin's welcome was replied to in appropriate terms by President W. F. Gorenflo.

The second session was called to order Monday afternoon and the annual address of the president was read by Mr. Gorenflo. He outlined the work of the executive committee during the past year, stating that some active work is now imperative in connection with the framing of a public utility bill which will probably pass the Mississippi Legislature at its next session. He expressed the opinion that the public utility bill would be welcomed by every central station in the state if drafted in such a way as to be fair to both public and public utility. Mr. Gorenflo urged the Association to take the necessary action to offer assistance in drafting such a bill.

Following this address a paper on Liability Insurance was read by P. B. Bissett of Hattiesburg. The author reviewed the purpose of liability insurance and some of its benefits, adjustments and the different ways of construing a policy. He showed that liability insurance among central stations in the South is yet a new development, and little understood. He said that in 1912 Mississippi lead all of the Southern States in losses, the loss being 67.7 per cent of the premium income of all liability premiums written in the state, while in Louisiana the loss was 26 per cent.

The discussion on this paper brought out the point that the rates for liability insurance are based on the normal moral hazard and physical hazard and experience throughout the state.

The session on Tuesday morning opened with a paper on lubrication, by R. L. Ellis, president of the Alabama Light & Railway Association, which took up points of interest to operating men in connection with manufacture, use and filtering of oil. During the discussion, Mr. Ellis stated he had found that for street railway service with heavy weights and slow speed, an oil of relatively high viscosity is most satisfactory. He also stated that for small and light bearings, a fairly light oil is used and about 6 per cent salvaged by use of a capillary filter. In regard to cost of oil for a turbine, Mr. Ellis stated that in his plant, where the output was about 280,000 Kw hours per month, the cost of oil was about $15.

The next paper on, Combustion and Boiler Efficiency was read by C. M. Rogers of Meridian. The author took up the subject of combustion and the causes of low boiler efficiency from a non-technical standpoint, discussing the fundamental principles and the chemistry involved. He also showed how to figure the air required by a furnace and how an excess of air decreases the efficiency. The discussion brought out the point that with the percentage of CO_2 in the flue gases lower than 15, the operation of the furnace was destructive to the furnace linings, it being difficult to secure fire brick that would stand up.

The afternoon session of Tuesday was opened by a paper on, Short Cuts in the Office of Small Electrical Concerns, by L. W. Wade of Vicksburg. This paper discussed a few short methods and forms that have been successfully used at Vicksburg, and tend to save time and labor. The author followed the account of a customer from the application for service to the collection of the monthly bill, outlining the nature of forms and entries made.

On Wednesday morning a paper was read by R. E. Perry of the Columbia Lamp Division of the General Electric Company on the new high efficiency lamp. This paper was illustrated with lantern slides and took up briefly the history of incandescent lamps, touching upon the development of the larger types of lamps for various purposes, leading up to a discussion of the new high efficiency street series tungsten lamps in sizes from 80 to 100 candlepower operating at 6.6, 7.5 and 20 amperes and also the 750 to 1000 watt multiple units. The author stated that due to the high temperature and the concentration of the filament in these lamps, the intrinsic brilliancy is very high, necessitating the use of diffusing globes or indirect fixture unless the light source is without the range of vision. Dome and bowl enameled steel reflectors have been designed, as well as other types of glass reflectors for these lamps. For street lighting a compensator unit has been designed permitting 20 ampere lamps to be burned on 6.8 ampere series circuits. The author of the paper stated that the lamps are especially adapted to lighting of large areas where the units may be hung high, including large stores, auditoriums, armories, factories, hotel lobbies, amusement parks, and street circuits.

At the executive session held Wednesday afternoon, the report of the nominating committee was read and election of officers held. The following were elected to serve during the coming year: A. H. Jones, McComb City, president; Charles Hays, of Columbus, vice-president; H. F. Wheeler, of Hattiesburg, Secretary and Treasurer. The executive committee was elected as follows: R. B. Claggett, A. B. Patterson, W. F. Gorenflo, A. H. Jones, Charles Hays, E. B. Booth, R. H. Smith.

Upon invitation from Hattiesburg, it was voted at this meeting to hold the next convention at this place April 12, 13 and 14, 1915.

The Philadelphia N. E. L. A. Convention.

As this issue goes to press, only a few days are left before the assembling of members of the National Electric Light Association in annual convention at Philadelphia. The program to be followed during the four days of sessions, beginning Tuesday morning, June 2, and ending Friday morning, June 5, was presented in the May issue. It shows an interesting number of topics for discussion, the reporting and preservation of which will add much new material to an already existing library of many volumes. In this conection it is a remarkable fact that new committees assigned to the investigation and development of the same and new topics from year to year bring to each convention features not previously touched upon and of vital import, concluding their work with the recommendation that much more is yet possible. Such is the extent of the problems involved in the generation, transmission and application of electrical energy, and such the necessity to be associated with an organization that stands for the highest and best progress both technical and commercial.

What the 1914 convention will accomplish no one yet can tell, and few dare predict, yet it is certain that high-water marks will be reached, the nature of which, together with other details, will be presented in our annual report through these columns of the next issue.

New Members of Office Staff of Society for Electrical Development.

The Society for Electrical Development, in selecting its office staff, has chosen, among others, Mr. John P. Mallett, a member of the American Institute of Electrical Engineers, whose duties will be to investigate the application of electricity for the various industries and to suggest further applications. The information thus gathered will be filed and indexed for the benefit of the members of the society.

Mr. Mallett is a graduate of Tufts College, where he took a course in electrical engineering. His experience includes six years with the Westinghouse Electric & Manufacturing Company, eight years as chief engineer of the Northern Electrical Manufacturing Company, and five and a half years as engineer in charge of the department for the development of special apparatus for commercial and government work at the Diehl Manufacturing Company. His experience qualifies him for the important work which the society is entrusting to him.

The information collected by Mr. Mallett, together with all other available information on the subject of the uses of electricity for light, heat and power, will be taken care of by the Commercial Exchange Bureau, which will be in charge of Mr. Theodore Dwight, who will conduct the correspondence upon such subjects, both with the members of the society and with the general public seeking information. Mr. Dwight was formerly assistant to Gen. Griffin, and was for some years assistant secretary of the American Institute of Mining Engineers, during which time his work has been of such a character as to render him particularly competent to take charge of the society's Commercial Exchange Bureau.

Mr. James Smieton, Jr., has been engaged as office manager and acting secretary-treasurer of the society. Other members of the staff are being secured, and the society expects to commence active work at once.

New Business Methods and Results

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

Ice-Making and Refrigeration.

Present day interest in refrigeration and ice-making is shown in the attention being given this subject by the National Electric Light Association. In the 1913 proceedings of the association, the report of the committee on refrigeration occupied 66 pages of comprehensive and interesting matter, including descriptions of systems and apparatus, power requirements, examples of plants in operation, and commercial methods used for obtaining the business. Another evidence of interest is the activity of the organized refrigeration interests, the third International Congress having been held at Washington, last fall. At this meeting, much was done to increase the knowledge of the subject, and to place the business on a scientific basis.

In connection with refrigeration, the central station can do one or more of four things. It can make ice and sell it; it can sell power to ice companies; it can sell current to owners of private refrigerating plants—or it can operate its own cold storage rooms. Ice can be made economically by central stations, for the central station has excess capacity during the summer, while the ice plant demand is small during winter. The peak of one curve fits into the valley of another, with a consequent improvement of the central station load factor, and a great reduction in the fixed expenses of generation equipment for ice making.

Whether the central station should go into the ice business, or simply sell the current required in the process is entirely a matter of local policy. Where there is no ice company in a town, it is entirely appropriate to combine the two lines of business. That this is accepted as good practice is shown by the fact that there are 150 or more combination ice and electric plants in operation in the U. S., with a total daily tonnage of about 3,500. If there is an ice plant in the town, and a possibility of supplying it with current, it is not usually wise to enter into competition with it, unless there is an abundant business for both enterprises.

Two methods of ice making are now recognized, one of which uses distilled water, and the other "raw" or undistilled water, usually obtained from wells, springs, or some uncontaminated source. The distilled water process requires large boiler capacity, even with a system of multiple evaporation. Since boilers and a fireman are necessary, there is of course, an argument for engine drive, nevertheless central stations are supplying many plants of this character with current. When the raw water process is used there is a decided advantage in the use of central station power, as only a small boiler equipment is necessary, and much labor, as well as investment charges saved.

In small towns, ice-making may be profitably combined with production of current, for the reason that the summer day load is insignificant, indeed in many cases the lighting company cannot afford to furnish day service, although certain power loads could be secured. In such a case the ice-making load supplies exactly the income necessary to make 24 hour operation not only possible but profitable.

In the larger towns and cities where ice companies are already established, there is a large field for the sale of current. In the U. S. there are over 200 steam driven ice plants, with a combined annual tonnage of over 12 million. As an instance of what has been accomplished in securing this business, the load of the Commonwealth Edison Company of Chicago may be mentioned, which is now over 2500 horsepower, with an annual consumption of over 5 million kw.-hrs. About half of the companies served are making ice from distilled water, the others from raw water. The annual load factor is between 50 and 60 per cent, and may reach as high as 65 per cent. The current is sold on an off peak schedule and in the larger plants is furnished at a rate as low as one cent per kw.-hr.

Besides the use of current for making ice, there is a large and increasing field for the operation of refrigeration machinery for dairies, meat and fish storage, drinking water systems, florists, hospitals, soda fountains, ice cream manufacturers, and cold storage in general. The size of these private equipments may vary from a 50 ton machine for use in beef and pork packing establishments, to as low as ⅛ ton or 250 pound machines for large residences and small tradesmen.

The successful operation of small machines for cooling ice boxes, etc., has been accomplished. One grocery store in Philadelphia, which has been using a ⅛ ton machine for preserving cheese and butter reports a current bill of about $100 as against nearly $200 for ice. A ½ horsepower motor operates the machine and stopping and starting it with a switch is all the attention it has required. The food products have been perfectly preserved for a length of time and under conditions impossible with ice.

Another important use of current is in connection with the icing of refrigerator cars, such as are used in the transportation of meats and fruits. In the San Joaquin Valley of California, two of the largest ice plants in the country are operated for this purpose. One of these has a capacity of 150, and the other of 90 tons daily

As suggested, the central station may also operate cold storage rooms of its own. The Lee Electric Light Company of Clarinda, Iowa, operates cold storage rooms of

TABLE I. COMBINATION ICE AND ELECTRIC PLANTS.

Location	Population	Size of Machine	Dollars Invested	Annual Production Tons	Tons per Capita	Cost per Ton	S. P. per Ton Wholesale	Gross Income	Net Income	Per Capita	Per Cent on Investment
Virginia	1800		$ 9,000.00	1000	.55	$2.25	$5.00	$ 5,000.00	$ 2,750.00	$1.50	20%
Florida	1700	10 T.	12,000.00	1700	1.0	4.10	5.00	12,000.00	5,000.00	3.00	42%
Illinois	3000	7 T.	10,000.00	1000	.33	2.00	4.00	4,000.00	2,000.00	.67	20%
Kentucky	3000	15 T.	9,500.00	1220	.40	2.04	5.00	6,100.00	3,600.00	1.20	40%
Kansas..	2300	15 T.	16,700.00	2800	1.21	1.35	2.75	12,000.00	2,580.00	1.12	15½%
Nebraska	3500	10 T.	10,000.00	1200	.33	1.28	4.00	7,500.00	6,000.00	1.71	60%
Illinois	6350		20,000.00	2000	.33		5.00	10,000.00			

200,000 cubic feet capacity. This company is located in a fruit growing region, and often holds in storage several thousand barrels of apples. This company has a due appreciation of by-products, for it sells exhaust steam in the winter for heating, and turns excess station capacity into refrigeration in the summer. A. G. Rakestraw.

Our Plans for the Remainder of the Year.

Following our custom in connection with the maintenance of the department of New Business Methods and Results, we present herewith the topics that will be discussed in the remaining issues of the year. Our aim in announcing these subjects in advance is to enable readers to prepare discussions or material of interest in connection with any topic. Further, any request to secure special data bearing on any subject will be carefully considered and an attempt made to comply with the request. The editors appreciate the cooperation that new business managers have given in conducting this department and only hope that it may be further used to advantage in discussing new business matters with our readers engaged in this phase of the electrical industry.

In the July issue the electric vehicle situation will be taken up. Commercial policies, electric garage possibilities and data on truck and delivery vehicles will be presented.

In the August issue, "Steam Heating and the Hotel Load" will be the main topic for discussion. Data on same and the favorable features will be presented.

The September subject will be one admitting variety of treatment. Changing over street lighting systems, commercial data on units and systems, house wiring suggestions with the necessary strings thereto, lighting tennis courts, securing small consumers, etc., will be subdivisions of the discussion. This is a discussion in which we invite all interested to take part.

The subject for the October issue will be "Electric Sign Development." In this connection it is planned to take up ordinances and regulations favorable to promotion of signs, and at the same time cause them to represent principles of safety, good advertising and efficient use of light.

In the November issue a general review of profitable Christmas new business schemes will be presented with suggestions for new ones. This issue will reach new business managers just at the time that arrangements are being made for securing special business during the month of December and should present material of value. We especially ask for outlines of any successful schemes that have been used in the past together with any data on same. These will be used or commented upon.

In the December issue, general and department store show window lighting and show case lighting with data bearing on same will be presented. This is a fertile field for development in the South. Anyone who has accomplished results should send details.

A Case Where Free Service Returns 100 Per Cent on Investment.

Since the summer of 1911, all central stations controlled by the H. M. Byllesby and Company have furnished electric fans and operated same without charge to all indigent invalids in the territory served. A profit has been realized on this service that cannot be estimated in cents per kw.-hr for city officials, business men, bankers, physicians and members of families benefited have written many letters commending the local companies for this charity, and a number of newspapers have seen fit to praise the companies for what they term a "direct and personal act of charity."

It is interesting to note also that where houses close to the lines are unwired, temporary connections and interior wiring are installed without charge. The fans are loaned as long as the attending physician thinks necessary. Company managers have handled the free fan offer creditably in the past and will continue to do so, according to Vice-President A. S. Huey, for by doing so have given the public a visible sign that corporations are able to find at least some ways of serving people in distress without financial reward. The good will of the public is secured through evidences of cooperative business policies. Here is a good chance for every central station to show its hand.

A New Field for the Commercial Use of Fans—An Opportunity for Central Station, Contractor and Dealer.

Proof that the full use of fan motors for commercial purposes has not yet been realized is found in the report of a recent issue of *The Emerson Monthly* on results secured from installing fan motors in commercial stables in St. Louis during the season of 1913. Last summer was one of the most severe and long continued heat ever experienced in St. Louis, and many of the local teaming interests suffered heavily from deaths of draft horses during the four months of excessive heat. Heavy mortality of animals of this class is to be expected under severe weather conditions in the latitude of St. Louis.

It seems, however, that this mortality can be greatly reduced, if not altogether eliminated, by artificial ventilation. The Union Fuel Company, of St. Louis, a corporation using a large number of horses, decided to experiment with the use of fan motors during the 1913 season, and the results of using fans in their stables were surprising even to themselves. It is stated on authority of the company that, although they were accustomed to lose from ten to twelve horses each summer out of the large number employed, their stables went through the severe 1913 season without the loss of a single horse. Some twenty oscillating fans were purchased through a local jobber and installed in the stables late in the spring- one fan being used for two or three animals.

A representative of the company states that the condition of the horses during the long, hot season was highly satisfactory, and the results of the experiment were very gratifying, as the record made in 1913 could be attributed to nothing else than the installation of fan motors in their stables, all being of the same opinion. From the standpoint of humane treatment of horses, there is no question that the use of fans will alleviate the discomfort of close quarters and long hours of severe effort under oppressive conditions. However, apart from this phase of the question, the use of fan motors becomes advisable from purely commercial reasons. The cost of teams such as employed by the Union Fuel Company ranges from $500 to $700 per pair, and the saving of a single animal of this character may easily repay the cost of fan motor equipment sufficient for 40 or 50 stalls.

It seems that the use of fan motors in large commercial stables should be a new and entirely practicable field. To develop this field it will be necessary to bring the possible savings to the attention of the management of each firm by personal solicitation. Here is a fan motor selling opportunity fo revery central station, contractor and dealer who will take advantage of it.

Important Commission Decision in Pennsylvania.

The Public Service Commission of the State of Pennsylvania has handed down a decision denying the application of the Schuylkill Light, Heat and Power Company permission to carry on a competitive electric lighting business in the Borough of Ashland, now served by the Eastern Pennsylvania Light, Heat and Power Company, a subsidiary lighting company of the Eastern Pennsylvania Railway Company, which is under the management of The J. G. White Management Corporation. The Commission held "that a reliance upon competition between public service companies for securing adequate service and proper rates has not been successful and that hereafter supervision by properly constituted authorities is to be substituted;" that competitive companies are invariably merged and the citizens are compelled to pay rates sufficient to give a return on the investment of duplicated properties. This is the first case of its kind to come before the Public Service Commission of Pennsylvania and its decision is of very great interest to all public utility properties in the State.

Reducing Number of Poles on Denver Streets.

In the city of Denver, Colo., the numerous sets of poles on the streets have been greatly reduced by the adoption of combination trolley and lighting poles. In regard to this system, W. G. Matthews, superintendent of the lines department of the Denver Tramway Company, has the following to say:

"While the question of 'joint lighting and span poles' may present novel features in some localities, we feel that here in Denver we now have a standard basis on which to work and that the experiment stage has long since passed, so that when the proposition of 'combination lighting and trolley poles' is brought up, it is merely a question of those interested getting together and arranging the cost element. It will be found on investigation that the local 'Traction Company' will necessarily have to extend a very liberal and public spirited policy and a hearty co-operation, in order to accomplish what has been done along this line in Denver, this company having expended to date, on the 'combination lighting scheme,' a little more than $32,000. The scheme as a whole is a marked improvement over the old way of having separate standards for lights and another for the trolley wires and so on and is generally approved by all."

Load Represented by Fans.

In an address before the Tri-State Water and Light Association, in convention at Atlanta recently, Mr. W. R. Collier, sales manager of the Georgia Railway & Power Company, said that the fan load alone in the city of Atlanta during summer is approximately 450 Kw. He also said that during 1913 his company rented approximately 700 desk fans for six months' use at a rate of $3.00 each. In commenting on the consumption of current-consuming devices, he estimated the Kw.-hrs. per year for 100 desk fans, 200 irons, 50 sewing machine motors, 50 percolators, 10 dental motors and 10 breakfast sets at 10,000 Kw.-hrs., and this load at no increase of the average peak.

Sale and Renewal of Lamps by the Union Electric Light and Power Company of St. Louis.

In the last issue of *Electrical Engineering*, mention was made of a new arrangement for the sale and renewal of lamps by the St. Louis Company. The rules governing such, as outlined in a recent issue of the company's house organ, are as follows: The prices set for lamps of the different types are also given.

1. Lamps will be sold to electric lighting service customers for use on company's system only.

2. Customers purchasing electric service at rates entitling them to free lamp renewals or lamp renewal allowances, who purchase from the company the first installation of such lamps and any increases thereof at the company's schedule prices, in securing renewals, shall be entitled to either free renewals or renewal prices as set forth in foregoing schedule.

3. Customers purchasing electric service at rates not including free lamp renewals or lamp renewal allowances may purchase lamps from the company at schedule prices, and no further discount or allowance shall be made on prices of lamps to such customers.

4. Customers having purchased the first installation of lamps from the company and desiring to substitute other lamps in place of the same, may return burnt-out lamps to the company with bulbs unbroken, and in such event will be permitted to purchase an equal number of other lamps of any kind or size sold by the company at schedule prices and obtain credit or allowance on the lamps returned, being the difference between the company's schedule sale prices and renewal prices. Such latter sum is to be applied to the purchase of an equal number of other lamps of either larger or smaller size or kind, providing however, no cash return in such exchange shall be made to the customer.

Schedule of Prices for Lamps

	Sale Price		Burnt-Out Allowance	
Size	Clear	Frosted	Clear	Frosted
10 watt, Carbon, Standard ..	$ .15	$....	$ .15	$ ...
20 watt, Carbon, Standard ..	.15	...	.15	...
30 watt, Carbon, Round	.19	.21	.08	.08
60 watt, Carbon, Round	.19	.21	.15	.15
30 watt, Gem, Standard	.15	.17	.15	.17
60 watt, Gem, Standard	.15	.17	.15	.17
100 watt, Gem, Standard	.15	...	.15	...
60 watt, Gem, Combination .	.15	...	.15	...
50 watt, Economical	.40	...	.20	...
5 watt, Mazda, Sign	.21	...	.05	...
10 watt, Mazda, Sign	.24	...	.09	...
15 watt, Mazda, Standard ..	.24	.26	.09	.08
25 watt, Mazda, Standard ..	.24	.26	.13	.12
25 watt, Mazda, Round	...	.43	...	.20
(All Frosted.)				
40 watt, Mazda, Standard ..	.24	.26	.20	.20
40 watt, Mazda, Round	...	.43	....	.20
(All Frosted.)				
60 watt, Mazda, Standard ..	.32	.35	.32	.29
60 watt, Mazda, Round	...	.61	...	.30
(All Frosted.)				
100 watt, Mazda, Standard ..	.55	.61	.55	.55
150 watt, Mazda, Standard ..	.87	.94	.87	.86
250 watt, Mazda, Standard ..	1.42	1.54	1.42	1.42
400 watt, Mazda, Round	2.68	2.88	2.68	2.68
500 watt, Mazda, Round	3.03	3.27	3.03	3.03
25 watt, Mazda, Tubular ...	.43	.47	.20	.20
35 watt, Mazda, Hylo	1.25	...	.35	...

Some idea of the volume of work handled through the lamp department is given by the following table showing the lamp deliveries during 1913, totaling 515,668 electric lamps on 85,364 calls. These deliveries were handled through three branch offices, lamp delivery automobiles and main office. The proportion of (carbon and gem) and tungsten lamp deliveries is interesting, being nearly in the ratio of 3 to 2.

Deliveries Carbon and Gem lamps	319,386
Deliveries Mazda lamps	196,282
Total deliveries	515,668
Consumers supplied during year	85,364
Consumers supplied each month, average	7,114
Consumers supplied each day, average	274
Lamps delivered to each customer	6

The city of St. Louis has a population of around 690,000, so that it is to be inferred from this data that the lighting business is rather active if not strenuous.

Ross B. Mateer, Commercial Agent, Southern Sierras Power Co., Comments on Benefit of Displays.

Display features, at least so far as attractive windows are concerned, cannot be given too much attention. You may have in mind some central station with a cashier's desk, a contract counter, and perhaps a bureau for kicks, but what of attractive displays? Small signs call attention to the various bureaus, and the consumer entering to make payments for current consumed during the past month has no other thought than to perform a duty. Do you desire such an idea instilled in the minds of your customer, or do you try to have them enter the office and leave the buildings carrying away with them some impression that will ultimately result in greater sales of current?

Perhaps, you will say, your office cannot afford salesmen to advocate the use of current-consuming appliances; perhaps you will state that advocating current-consuming appliances is up to the manufacturer, and not to the quasi utility. Whichever opinion you incline towards, the fact yet remains that a portion of the rental charged for floor space in your office should be pro rated to display space; yet what are you getting for such a rental charge? Are you content to have your windows merely clear glass, attracting no attention, or is it your desire to have the appliance stock an attractive display feature? Undoubtedly you will say the latter, but it is then a case of "practice what you preach." Inaugurate an aggressive commercial campaign; convey your idea, if not by solicitation, then by suggestion, such as is possible with an attractive window or feature display.

Many companies hesitate to gauge the value of small current-consuming appliances, yet have within recent years become boosters and now estimate the number of appliances on their line by the thousand. Their annual reports state the revenue as received from small current-consuming appliances to be approximately $100,000 to $300,000 per annum. Do you think such excellent revenue was acquired in one day, or was it secured by a combination of aggressive solicitation and attractive window display?

Too much stress cannot be given to the subject of display features. Utilize your windows for a display of electric irons, coffee percolators, toasters and curling irons. Feature, if you will, such articles and endeavor to have entirely new arrangements of the window to greet the eye of the passer-by each day. These and attractive cards, stating the cost of operating such appliances, calling attention, if you please, to the method of securing small current-consuming apparatus by a small payment down and the balance in monthly installments, encourage sales. Utilized windows pay their proportion of rent, which is a fixed expense, and must be met with displays that attract, create a desire to own and result in a sale. Therefore appreciate your display windows; make them salesmen, conveying to the pedestrian a message, insistent and impelling, by dising in an attractive manner the small current-consuming appliances that are so popular today.

A Window Display Used by the Narragansett Electric Lighting Co., Providence, R. I.

An interesting and novel window display designed for the purpose of arousing a more extensive popular interest in electric elevators, has recently been used by the Narragansett Electric Lighting Co., Providence, R. I. The display consists of attractively colored photographic enlargements of the Woolworth and other tall tower buildings in New York, brightly illuminated from behind. By a clever mechanical arrangement, the si xelevators in the tower of the building are shown in a continuous journey up and down to various floors. A small motor connected to batteries within the model supplies the necessary power, the lighting effects being obtained by connection with a convenient lighting circuit.

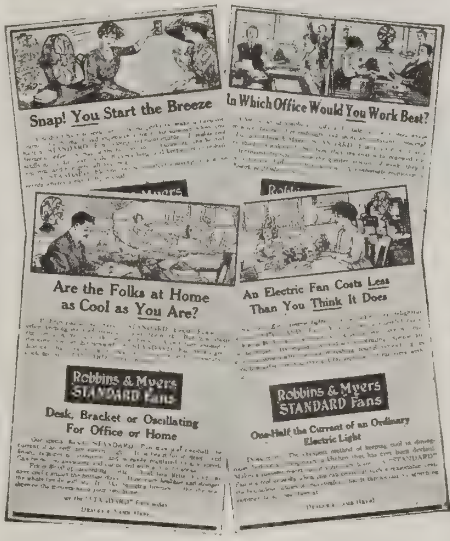
Two printed cards, which accompany the model, state the number of elevators in the building and call attention to the advantages of the electric type of elevator. The display is one that is particularly appropriate for the central station window and is in line with the educational work now being done to increase the use of electric current consuming devices.

WINDOW DISPLAY OF NARRAGANSETT ELECTRIC LIGHTING COMPANY, PROVIDENCE, R. I.

Co-operative Ways and Means for Profitably Promoting the Interests of Electrical Contractors and Dealers.

In the March issue of *Electrical Engineering* the educational work in electrical merchandising now being carried on by a large manufacturer and jobber was discussed. In what follows the ways and means employed by another manufacturer to promote the interests of the electrical contractor and dealer, and finally their own business, are taken up, for the reason that such ways and means indicate a co-operation in the electrical trade that is neither selfish nor one-sided. The greatest benefit results when both parties interested make the fullest use of the schemes at the time, yet the effect is cumulative and will not only be felt this year, but next in new demands and increased sales. Since May is the rush month among most southern electrical dealers, no doubt the effect of the co-operative methods to be mentioned can be estimated in a substantial way at the time that this issue is being read.

Booklets Supplied Dealers With Imprint.


Snap! You Start the Breeze
In Which Office Would You Work Best?
Are the Folks at Home as Cool as You Are?
An Electric Fan Costs Less Than You Think It Does
Robbins & Myers STANDARD Fans
Desk, Bracket or Oscillating For Office or Home
Robbins & Myers STANDARD Fans
One-Half the Current of an Ordinary Electric Light

Newspaper Ads for Dealers.

Motion Picture Slides.

Robbins & Myers STANDARD Fans
Make This the Coolest Summer You Ever Knew!
Robbins & Myers STANDARD Fans
Prices As Low As $9.00 Consumes Less Current Than One Electric Light
Look for the Flag on the Guard
FOR SALE BY
The John Rhoades Sons Co., 14 N. High St.
Built For Long Wear Swift, Silent, Steady All Sizes and Styles
Look for the Flag on the Guard

Street Car Card.

A number of illustrations are shown here that are designed to secure the interest of customers of some electrical supply store, and, if their mission is fully performed, will cause such customers to go to this store and ask for the device mentioned, which, in this case, happens to be an electric fan. These illustrations show types of advertisements prepared by the Robbins & Myers Company for use by dealers, and fit in with a well-laid-out advertising campaign, using publications of world-wide distribution. The messages of these advertisements are prepared with the idea of educating the public in the advantages of electric fans and small motors. In doing this, and by publicity in the electrical journals read by the electrical dealer, he is first helped by a broadening of the market for his goods and services, and then solicited to take advantage of the scheme—a proposition which is, indeed, fair, and on this account worthy of support.

The particular features of support in creating sales for fans and motors for electric dealers are through supplying advertisements for publication in local papers, furnishing attractive booklets and folders for distribution, window display suggestions, and moving picture theatre slides of an educational character, in each case providing plenty of room for the dealer's name.

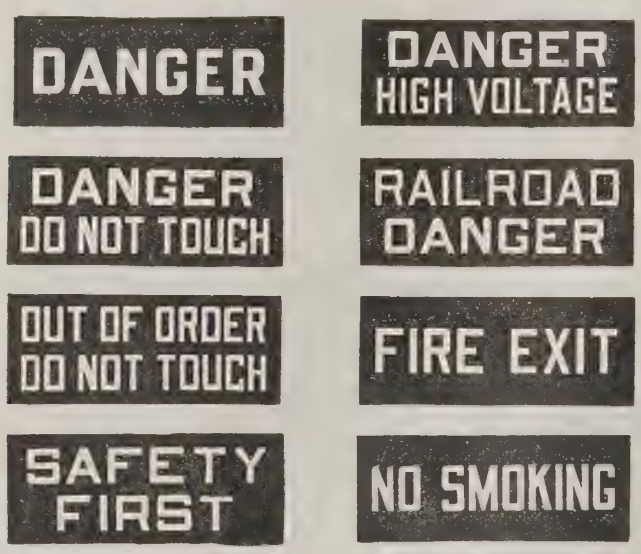
The dealer's window is one of his best advertising assets, and one which costs him practically nothing to maintain. In fact, if used judiciously it should go a long way toward paying the rent. On this account every wide-awake dealer can make good use of window display suggestions made by those who are experts on and know in detail the essential technical and commercial features of the goods handled.

In addition to the advertising helps mentioned, a rather interesting opportunity offered by the Robbins & Myers Company to dealers handling its products, is competition in a window display contest, with cash prizes aggregating $15,000. This contest is made possible through being a member of the Rice Leaders of the World Association, and embodies among the conditions that an association emblem banner that is furnished shall be a part of the display. The prizes are $2,000 for first, $1,000 for second and $500 for third, and so on down in amount, and given to 450 dealers who have the best window displays during 1914. Every dealer who enters the contest and sends a photo of his window, whether or not he wins one of the cash prizes, will be presented with an album of the 100 best window displays competing. This in itself will be valuable to the dealer, since it will contain ideas that he can use.

In addition to the window display contest, an idea letter contest is to be carried on and cash prizes aggregating $10,000 distributed for the best letters telling in 50 words or less the merits of Robbins & Myers products or those of other members of the Rice Leaders of the World Association.

Standardization of Danger and Safety Signs.

The National Electric Light Association, in co-operation with the National Association of Manufacturers, the National Metal Trades Association and the National Founders' Association, has approved as standard the types of caution and safety signs shown in the accompanying illustration and arranged to supply these signs to members and those interested at a very moderate price. All but the "Safety First" and the "No Smoking" signs are red, the background of these two being green. The signs are printed on linen, 7 by 18 inches, suitable for mounting on walls and partitions, or they may be fastened to wooden or cardboard backs and hung in appropriate places. For use in damp or exposed places, they require varnishing only.



Danger and Safety Signs Adopted as Standard by N. E. L. A.

A type of portable all-metal floor sign with standard has also been approved for both inside and outside use. Announcement is made that suggestions for signs bearing other wording will be considered and printed if the demand will warrant. The cost of the linen signs shown in the illustration in sizes 7 by 18 is 60 cents per dozen, and they can be secured from the secretary of the National Electric Light Association, 29 West 39th street, New York City.

It's This Way With Central Station Officials Sometimes.

"Where's the president of this railroad?" asked the man who called at the general offices.

"He's down in Washington, attendin' th' session o' some kind uv investigatin' committee," replied the office boy.

"Where's the general manager?"

"He's appearin' before th' Interstate Commerce Commission."

"Well, where's the general superintendent?"

"He's at th' meetin' of th' legislature, fightin' some bum new law."

"Where is the head of the legal department?"

"He's in court, tryin' a suit."

"Then, where is the general passenger agent?"

"He's explainin' to th' commercial travelers why we can't reduce th' fare."

"Where is the general freight agent?"

"He's gone out in th' country t' attend a meeting o' th' grange an' tell th' farmers why we ain't got no freight cars."

"Who's running the blame railroad, anyway?"

"Th' newspapers and th' legislatures."—*Pittsburgh Press.*

Electricity vs. Gas—An Idea for New Business Managers.

BY ALBERT SCHEIBLE.

Next to catchy illustrations, there probably is no form of newspaper advertising which makes a stronger impression on a large share of the general public than that based on the so-called "deadly parallels." But these must have some clever feature for holding the reader's attention, otherwise he may not have the patience to look through a long list of parallels or contrasts. The fascination of tracing a series all the way through the alphabet supplies such a feature for holding the reader's continuous attention and the series given herewith ought to interest as well as influence a large number of men and women if reprinted in the local newspapers. This scheme therefore can be used by new business managers to advantage.

ELECTRICITY.	GAS.
Adaptability to all sorts of places and conditions.	Asphyxiation—a danger always faced by users of gas.
Beauty easily obtained in all electric devices.	Broom—an antiquated means of raising dust, still used by those who have no current at hand for operating a vacuum cleaner.
Convenience and Cleanliness—two striking points of superiority of electrical devices.	Chimneys—which will break, adding more to the cost of gas than most people realize.
Distribution of the light—readily obtained with electric lamps as they can be placed wherever needed.	Deterioration—makes a gas mantle show only half or two-thirds its initial candle power after a few weeks of service.
Extensions—so easily made in emergencies to bring the current where it is wanted.	Explosions—obtained whenever air has mixed with gas before it is lighted; often costly and serious.
Flat Irons and Fans—the housewife's joy, if electric.	Flaring and Flickering—the eye-straining quality for which gas lamps have always been noted.
Galvanic—one of the numerous types of electro-therapeutic apparatus used to relieve bodily ailments.	Gasoline—the still more dangerous younger brother of gas, used for propelling autos by those not familiar with the smoother running of the electric car.
Hair-Drier—a ladies' treasure available to all users of electric light.	Heat—supplied in great surplus by gas, whether you want it or not.
Ingenuity—one of many qualities in which electrical devices excel.	Illumination—a service of which most gas companies ignore, evidently from fear of where it would leave them in the competition.
Juice—a popular term for man's greatest servant.	Jet—the color towards which ceilings tend where gas is used
Kinks—in the hair, yield quickly to an electric curling iron	Killing—often due to the slow poisoning by escaping gas, as comparatively few houses have gas pipes free from leakage.
Laundrying—once a drudgery, now made easy by electric washing machines, wringers and flat irons.	Leaks—Not always easy to detect in gas pipes and gas joints, but likely to cause explosions and headaches.
Meters—far more accurate for electricity than for gas.	Matches—common causes of fires, still needed with gas.
Nerves—soothed by the use of electric massage apparatus and by riding in the quiet-running electric autos.	Nervous troubles—often due to the carbon monoxide which which forms a part of ordinary illuminating gas.
Ozone—cheaply made electrically where water is to be sterilized or where large assemblies need better air for breathing.	Oxygen—consumed by all gas devices, though there rarely is any to spare indoors.
Power—instantly available in any desired form where current is to be had.	Pressure—keeps bobbing up and down with gas, while the voltage of the electric current usually is a model of steadiness.
Queens—invariable users of electrical devices, the new British Queen, Mary, having recently had a handsomely mounted hair drier built specially for her by an American manufacturer.	Quality—a variable in gas, but never in electric current.
Reflectors—easily used with electric lamps to secure the most efficient use of the light, but much harder to use with gas jets, as the heat and soot will spoil the reflecting surface.	Repairs—a term almost unknown to those using electric runabouts.
Switch—a device for turning on an electric light or off in the twinkling of a second.	Soot, Smell, Smoke—all three undesirably familiar to gas users.
Tungsten—the modern money-saver in indoor lighting.	Tubing—a clumsy, leak-breeding substitute for an electric lamp-cord.
Uses—found almost without end by the electric current.	Underwriters' Rules—Wise restrictions, limiting the use of gas engines.
Vacuum Cleaner—one of the many sanitary appliances available to every user of electric current.	Ventilation—sadly missed all summer by those dependent on gas.
Wash-day—formerly a synonym of terrors; now changed by electrical devices to a day of satisfaction.	Waste—Quite the rule with gas lamps, as they cannot be turned on and off instantly with a switch.
X-Rays—one of the many wonder-working forms of applied electricity which have no counterpart among gas appliances.	Xantippe—what gas tends to make of the wife who misses the comforts of electric lights, electric flat-irons and electric fans.
Young—true of applied electricity in years, but not in development or achievement.	Yoke—emblem of servitude, felt by those whose labors have not yet been lightened by the use of electrical appliances.
Zwieback—the slowly-baked ancestor of the toast now so quickly prepared at the table on an electric toaster.	Zip—a hissing sound, as of escaping gas or of the flame flaring through a cracked mantle.

Questions and Answers from Readers

Readers are invited to make liberal use of this department for discussing questions, obtaining information, opinions or experiences from other readers. Discussions and criticisms on answers to questions are solicited. However, editors are not responsible for correctness of statements of opinion or fact in discussions. All published answers and discussions are paid for.

CONVENIENT TEMPORARY RESISTANCES.

Editor Electrical Engineering:

(456) In various cases we have occasion to use resistances under 10 ohms to cut down the value of supply voltage. Up-to-date steel telephone wire has been used. Will readers advise other convenient resistances that may be used, the values of which can be calculated or measured without elaborate apparatus? Wm. C. H.

H. P. OF MOTOR TO OPERATE PUMPS UNDER VARIOUS HEADS.

Editor Electrical Engineering:

(457) I would appreciate reference to data on pumps that shows the electrical horsepower required to raise a certain quantity of water under various heads. If possible, I would like to secure a curve sheet showing values of horsepower on the horizontal and values of head in feet on the vertical for pumps capable of delivering 100, 200, 300, 500, 1,000 and 1,500 gallons per minute. The pumps for which these data are required are single stage, single suction centrifugals for heads of from 10 to 100 feet. W. J. R.

MEASURING SINGLE-PHASE POWER FROM A THREE-PHASE CIRCUIT.

Editor Electrical Engineering:

(458) Please advise if a three-phase meter used to measure power taken by motors on a 110-volt A. C. circuit will measure correctly any power used for lighting and single-phase motors that may be taken off any phase.

W. A. C.

TRANSFORMERS LOSSES, SINGLE VS. THREE-PHASE.

Editor Electrical Engineering:

(459) The writer has heard it said that for a single-phase transformer installation to serve single-phase motors the transformer losses are from 15 to 35 per cent less than in three-phase installations of the same size. If this is so, I would like to see an explanation in the Question and Answer columns. R. S. T.

REPAIRING ELECTRIC FANS.

Editor Electrical Engineering:

(460) As a reader of the Question and Answer section of *Electrical Engineering,* the writer would like to see in an early issue a discussion of testing for trouble in electric fans, giving schemes for telling whether trouble is in the armature or fields, how to locate short circuits in armature, how to find bad coil or coils and cut out same, etc. The discussion should be undertaken with the understanding that no elaborate testing outfit is at hand, and only plant sizes of instruments and commercial circuits for testing available. The fans I am particularly interested in have 110-volt, D. C. motors. Albert W.

ARRANGEMENT OF LAMPS FOR SPECIAL DISPLAY.

Editor Electrical Engineering:

(461) A special display to burn about 4 hours will require 50, 6-watt, 6-volt lamps in multiple. These lamps must be operated by batteries, either dry or wet. How many will be required? Also, I have 53—5-watt, 13-volt lamps connected to 110-volt supply in 5 banks of 10 lamps in multiple, and one of three in multiple. These banks are connected in series. How much resistance must be placed in series with the lamps to make them operate without burn-outs on the 110-volt supply? K. W. H.

CHANGES REQUIRED TO CONNECT 2-WIRE D. C. GENERATOR TO 3-WIRE SYSTEM.

Editor Electrical Engineering:

(462) Please advise if a 220 volt, six pole, 2-wire, D. C. generator can be used successfully to supply a 3-wire, 110-220 volt circuit when lamps of same size are used. Also show a diagram and explain how to connect the armature winding of the 2-wire machine to slip rings and take off a third wire through use of inductance coils, so as to operate a 110 and 220 volt Edison 3-wire circuit satisfactory. Would such an arrangement change the capacity of the generator which is 50 kw as a 2-wire machine? V. K. S.

Heating a Brick Factory by Steam. Ans. Ques. No. 428.

Editor Electrical Engineering:

The conditions as presented in the problem outlined by F. G. Flickinger are perhaps representative of many installations throughout the country, and are, without doubt, not to be envied. This instance is certainly typical in conspicuously showing the lack of expert or engineering advice relied on when planning or considering such installations, and the least that may perhaps be said, as a word of warning, is that "an ounce of prevention is better than a pound of cure." Nevertheless, it is not too late to advise with a competent party when such conditions are recognized, so that a remedy may be proposed and its merits discussed. It is hoped that these remarks will not be misconstrued as personal in any respect, but that they will be received in the spirit of their intentions. Mr. Flickinger is, therefore, to be congratulated on the steps taken to secure a discussion through these columns.

The boiler plant, as given, aggregates a total of 110 Hp., and this is intended to fulfill an engine demand ranging from 90 to 115 Hp., using 28 pounds of steam per horsepower for one hour, and the requirements for supplying 2,086 square feet of direct pipe-coil radiation, together with the necessary steam for drying purposes. One boiler horsepower under average conditions will generate 30 pounds of steam, and allowing for the usual losses in transmission, leakage, etc., the total output would be about 2,640 pounds, or just about enough to take care of the engine load. How the other conditions are taken care of remains a puzzle, even though the boiler may be run at a load in excess of the rated capacity. The practice of overloading a steam boiler is not only lowering its average economy, but shortening the total life of the apparatus. A well recognized fact as to the capabilities of a boiler may best be given in the words of an eminent authority:

"A boiler rated at any stated number of horsepower should be capable of developing that capacity with easy firing, moderate draft and ordinary fuel, while at the same time exhibiting good economy; and, further, the boiler should be capable of developing at least one-third more than its rated horsepower in order to meet emergency at times (only) when maximum economy is not the most important object to be attained."

In order to give a direct answer to the questions in hand, and not to prolong a discussion as to merits of the numerous recommendations that may be made, a further analysis of existing conditions will follow: In the first place, heating with high pressure steam, now to be found only in a comparatively small marine practice, is more expensive than heating with low pressure or exhaust steam where available, not only because of the higher fuel and steam consumption, but on account of the excessive leakage and accompanying repairs. It seems that the pipe-coils used in heating this building were originally installed with the intention of using a high pressure steam supply, and would, therefore, not be sufficient to keep the interior at a comfortable temperature when using low pressure steam.

In low pressure heating systems it is customary to use 1¼-inch and 1½-inch pipe for coils, and sometimes 2-inch is used. Under ordinary conditions, 4,166 square feet of radiation would be required to heat this building, or a total of 9,600 lineal feet of 1¼-inch pipe coil. If space requirements do not allow for this additional increase in the run of piping, then 2-inch coils may be used. This would mean that the present coils be removed and 6,000 feet of 2-inch pipe be substituted. A study of the figures herewith will readily show the economies of heating buildings with steam at different pressures. In the "vacuum" and "atmospheric" systems of heating, the pressure may range from three ounces to one pound per square inch as recorded by a steam gage, and for ordinary low pressure systems the pressure ranges from two to five pounds, with exceptional instances in inadequate systems where the pressure has to be increased to ten pounds.

RELATIVE ECONOMIES OF HEATING UNDER DIFFERENT STEAM PRESSURE.

Gage pressure, lbs. per sq. in.	Lbs. steam condensed per sq. ft. radiation per hour.	Heat transmission per sq. ft. per hour in B.t.u.
0	0.29	275
5	0.40	380
15	0.54	510
30	0.68	650
100	1.25	1180

Taking up the further question as to the possibility of using gas as a fuel, and doing away with line shafting for machine drive, it is understood that the cost of gas is as low as 10 cents per 1,000 cubic feet, and that electric current is sold by the central station at the high rate of 3 cents a kilowatt-hour. Also, the price of coal will be taken at the higher figure of $1.75 per ton delivered. Individual motor drive is, under many conditions, quite economical, but the deciding factor lies in the extent and time of use of the driven apparatus; therefore small groups of shaft-drive will sometimes prove more favorable. An estimate of the operating costs under the present conditions of the plant may be placed at $7,500 per year, and the total energy generated as 150,000 kilowatt-hours, giving an average cost of about 5 cents per kilowatt-hour, or about 40 per cent higher than central station service.

As to the use of gas-fired boilers, the Federal government engineers state that "when the cost of 20,000 cubic feet of natural gas is cheaper than one ton of coal, the boiler is equipped with burners, pilot light and governor." The figures below will no doubt help to convey a clearer idea, under the conditions given, as to the relative merits of using gas for boiler fuel as against coal:

RELATIVE ECONOMIES OF GAS AND COAL AS BOILER FUEL.

One Ton Coal of
10,000 B.t.u. = 20,000 cu. ft. nat. gas = $1.75 for coal and $2.00 for gas
One Ton Coal of
11,000 B.t.u. = 22,000 cu. ft. nat. gas = $1.75 for coal and $2.20 for gas
One Ton Coal of
12,000 B.t.u. = 24,000 cu. ft. nat. gas = $1.75 for coal and $2.40 for gas
One Ton Coal of
13,000 B.t.u. = 26,000 cu. ft. nat. gas = $1.75 for coal and $2.60 for gas
One Ton Coal of
14,000 B.t.u. = 28,000 cu. ft. nat. gas = $1.75 for coal and $2.80 for gas
One Ton Coal of
15,000 B.t.u. = 30,000 cu. ft. nat. gas = $1.75 for coal and $3.00 for gas

M. William Ehrlich (N. Y.).

Heating a Brick Factory by Steam. Ans. Ques. No. 428.

Editor Electrical Engineering:

An attempt at a satisfactory solution of Mr. Flickinger's problem, named in question No. 428 in the January issue, would probably take up more space than the circumstances warrant, and, even if space were available, any long-range solution of the case could hardly be entirely dependable. It is really a question for careful investigation by a skilled consulting engineer, and a couple of hundred dollars or so invested in fees for such an investigation would doubtless yield several hundred per cent returns in fuel saved the first year. The problem presents no particular difficulties for a competent engineer, but yet, on the score of economy, it is not a matter at all to be entrusted to anyone that is not thoroughly versed in the practical application of the laws of the conservation of steam.

In general, it would be best that the power for the factory should be furnished by the steam engine and the exhaust therefrom utilized in the dryer and the heating plant. But this arrangement would probably involve some additional back pressure on the engine, and the latter may not be large enough to overcome this drawback and at the same time operate the factory. Conditions may be such, however, that vacuum apparatus might be advantageously installed so as to reduce this back pressure to the point where the engine could carry the load, and thus enable the exhaust to be utilized as aforesaid. This is a matter that could be determined only by a close study of the actual conditions.

The use of live steam throughout for power, heat and drying purposes seems not only a wasteful arrangement, but there is also the question whether the present boiler equipment could supply sufficient steam. The engine developing 115 horsepower at 28 pounds of steam per horsepower hour would require 3,300 pounds of steam per hour, while the factory heating—assuming that each square foot of radiation condenses one-third pound of steam per hour—would require 2,086 ÷ 3 = 700 pounds, nearly, of steam per hour. The total steam requirements for power and factory heating only is, therefore, 4,000 pounds per hour, or about 133 boiler horsepower, figuring roughly that a boiler horsepower is equivalent to 30 pounds of steam per hour. If the two boilers have but 55 horsepower capacity each, this means an overload on them of nearly 20 per cent, which is about all they should be expected to stand continuously. It would seem, then, that for the dry kiln supply recourse must be had to the engine exhaust, or the additional boiler capacity must be installed.

To substitute gas for coal as boiler fuel doesn't, on paper, promise to be productive of any particular economy. Tests indicate that about 20,000 cubic feet of gas (natural) is equivalent to one ton of coal when burned in the boiler furnace. At 10 cents per 1,000 cubic feet, this would be equivalent to coal at $2.00 per ton.

Neither does the electric motor drive appear economically feasible in Mr. Flickinger's case. Assuming that the present power transmission loss does amount to 50 per cent of the power developed by the engine, then the total actual power required to operate the machines would be 115 × .50 = 57.50 horsepower. There are few factory motor drives in which the over-all transmission efficiency would exceed 75 per cent. Taking, then, 75 per cent efficiency as a fair figure, the total electric energy required to operate the machines would be 57.5/.75 = 76⅔ horsepower; or, since 1⅓ horsepower = 1 kilowatt in electric units, the power required = 76⅔/1⅓ = 57.5 kilowatts, or 57.5 × 10 = 575 kilowatt hours for a ten-hour day. At 1 cent per kilowatt hour, this amounts to $5.75 power cost per day.

In the case of the engine, were the exhaust entirely utilized in drying or factory heating, the proportion of fuel expense to be charged against power production would hardly exceed 50 cents for the entire ten hours. Were the engine exhaust turned directly into the atmosphere and wasted, the fuel bill for power would rise to $4.00 or $4.50 per ten-hour day.

Both dry kiln and heating plant should be provided with closed condensation tanks, and pumps or traps for returning the water of condensation to the boilers at the highest possible temperature. This water will reduce the fuel expense 10 to 15 per cent if returned to the boilers at or about the temperature of condensation.

V. C. Vance (Cal.).

Nature of Magnetic Blowout. Ans. Ques. No. 427.

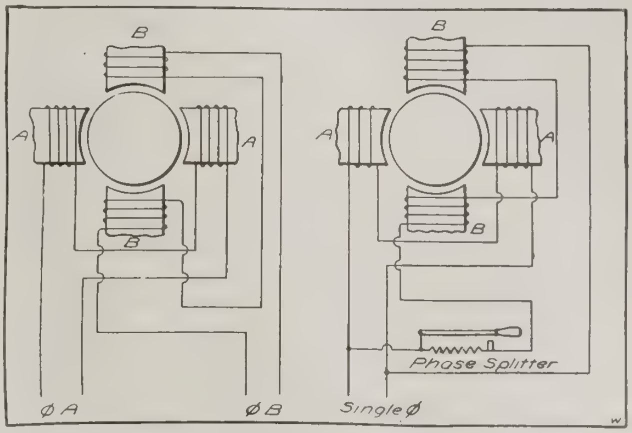
Editor Electrical Engineering:

The magnetic blowout makes use of the principle that a conductor carrying current tends to move in the presence of a magnetic field. On this principle depends the operation of all electric motors. An electric arc is a conductor of electricity and if a magnet is placed near it it will be deflected and if the force is strong enough it will be disrupted. This principle is made use of in large D. C. circuit breakers, street car controllers and many other pieces of apparatus. The construction consists of strong electric magnets so placed that the arc resulting from the opening of the circuit will be acted upon by a powerful magnetic field. The result is that instead of an arc being drawn out it is broken quickly with a sharp report. The magnet coils are usually placed in series with the main circuit so that the more current in the arc the more readily it is broken.

Nature of Field in Single Phase Motor. Ans. Ques. No. 435.

In answer to question 435 I would say that when a polyphase induction motor has reached synchronous speed, all but one of the phases can be disconnected and the motor will still continue to run with a revolving field. However, this same motor will not start on one phase wthout some special device to produce a revolving field. Such a device is called the phase splitter. Referring to Fig. 1, we see that coils AA are connected to one phase and BB to another phase, producing a rotating field. If however, we have a single-phase supply, the connection is made according to Fig. 2, coils AA being connected directly on a line, while coils BB are connected through a resistance. The effect of this resistance is to throw the current in coils B out of phase relationship with coils A, giving a rotating field. After the rotor has attained a synchronous speed the resistance is short circuited and the motor continues to run.

A. G. Rakestraw.



CONNECTIONS FOR SINGLE PHASE MOTOR OPERATION.

Nature of Field in Single-Phase Motor. Ans. Ques. No. 435.

Editor Electrical Engineering:

A single-phase motor has a revolving field when up to speed, after the starting arrangement has been cut out. This is due to the fact that what is known as the speed field is induced in the machine, due to the generator action of the rotor conductors in the stator field. These conductors, when the rotor is up to speed, or in fact rotating at any speed, cut the lines of force of the stator field, causing a current to flow in the rotor conductors, which induces a field proportional to the speed and 90 degrees out of phase from it. At synchronous speed this field is equal to the stator field, so that we have practically the conditions of a two phase motor, creating a revolving field in the same way.

A machine of the Edison two-pole, D. C. type, having its poles wound for 110 volts, A. C., would probably not run, or at least would not pull an yload, and would in all probability burn up, as it would be practically the same as a locked motor even if brought up to speed. This is due to the high reluctance of the magnetic path, at the point where the speed field would tend to form. The shape of the frame would have little effect on the performance of the machine. A four pole type of motor would work quite well if the two opposite poles were wound for 110 volts A. C. and the other two left without any windings. It would have to be brought up to speed in some way, the same as any single phase motor.

Reducing Supply Voltage for a Particular Load. Ans. Ques. No. 433.

To reduce the voltage across a bank of 190 six volt lamps, connected in ten series groups of nineteen, across 114 volts, to 105 volts, the following calculations are used. Since the lamps are six watt, six volt, the current drawn by each will be one ampere, and the resistance of each is six ohms. A group of 19 in series, with one ampere flowing through them, would have a drop across the entire group of 114 volts, or the line voltage. Ten of these strings in parallel would have a resistance of 11.4 ohms, and the entire bank would draw 10 amperes and have a consumption of 1140 watts.

If an external resistance of one ohm is placed in the circuit, making the total resistance 12.4 ohms, the current through the circuit when placed across 114 volts will be 9.2 amperes. This current flowing through the circuit will give a drop of 9.2 volts across the resistance, and 104.8, or practically 105 volts across the lamp bank. This will be 5.52 volts per lamp, and the current per lamp will be 0.92 amperes, making the watts consumption per lamp 5.08 watts. The consumption of the bank and resistance will be 1048 watts, or 92 watts less than without the resistance in the circuit. The watts taken by the bank will be 964, while there will be a loss of 84 watts in the series resistance. The resistance will have to be then, one ohm and have surface sufficient to radiate 84 watts without becoming dangerously hot. L. M. Klinefelter. (Colo.)

Switching Apparatus for 11,000-Volt Distribution Line. Ans. Ques. No. 434.

Editor Electrical Engineering:

The cost of switching apparatus necessary on a 11,000-volt distribution line, such as mentioned by F. S. F., in the questions 429 and 434, will vary according to conditions, and sufficient information is not given to even roughly approximate it. The switching layout will be affected by the nature of the load and as to whether the 11,000-volt line is built from the station or fed from some point on a main transmission line.

If complete lightning protection and overload oil circuit breakers are installed at the station, a suitable pole top switch will be satisfactory for the 11,000-volt line at the station, but if no lightning protection or overload circuit breakers are installed in the station, it would be advisable to install all switching, lightning arresters and fuse equipment outdoors, mounted on the roof of the station. It is considered good practice to install disconnecting switches in each high tension line, so that when it becomes necessary to inspect oil switches, the line can be absolutely "killed." Inasmuch as ordinary disconnecting switches are not intended to open a loaded circuit, and due to the fact that in emergencies such switches are apt to be opened, it is best to use a pole top switch capable of opening loaded circuits. Such apparatus is made in suitable sizes and types, notably by the Delta Star Electric Company, of Chicago, Ill., and the Railway & Industrial Engineering Company, Pittsburg, Pa.

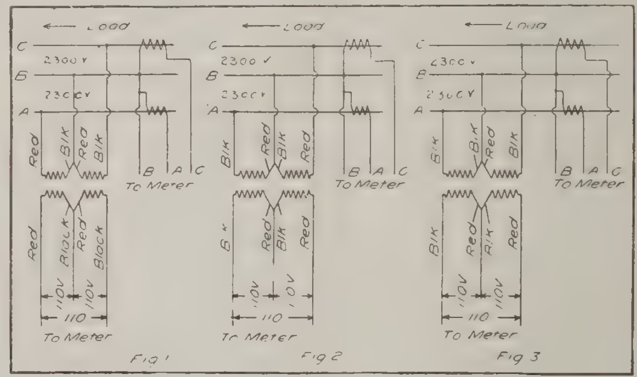
As far as protection goes, horn type apparatus is attractive on account of its low first cost and maintenance charge, and in most cases, for lines of the sort under consideration, such apparatus is most satisfactory. This apparatus is also designed by the above companies, and their bulletins fully cover types for different conditions.

A. H. (Ga.)

Method for Connecting Instrument Potential Transformers. Ans. Ques. No. 438.

Editor Electrical Engineering:

Referring to Fig. 2 of question 438 in the March issue, it is seen that the connections for the primary circuit are the reverse of those in Fig. 1, with the secondary connections, also reversed, making the potential circuit electrically the equivalent of that in Fig. 1. In Fig. 3 an error has probably been made in showing two black leads instead of a black and red lead for the left-hand transformer. The left-hand lead tapped into line A, is probably meant to be red, hence, the primary circuit is the equivalent of that in Fig. 1, while the secondary circuit is the reverse of Fig. 1. Therefore, the result is a potential circuit electrically opposite to that in Fig. 1 or 2. This being the case, the meter will run the reverse of that it would if connected as in Fig. 1 or 2.



The usual function of the red and black leads are to show the relative instantaneous direction of current flow, although in some cases it is used to distinguish the inside coil terminal from the outside lead. In such cases it may not show the relative direction of current flow. The former is the use I believe that is made of the colors of the leads in the case mentioned, at least it is the usual one for such apparatus.

When connecting one element at a time only, the load of a single-phase is registered and one element is connected to a different phase from the other, so that one would read lower than the other unless the loads were accurately balanced, which is never the case.

Changes in Exciter for Use With Alternator on Increased Voltage. Ans. Ques. No. 441.

In regard to question 441, the writer would advise the elimination of the commutator from the machine and use separate excitation alone. If the field coils were designed with a liberal amount of copper, it may be possible to use them alone. Load the generator to 125 Kva and measure the exciting current necessary to maintain the required terminal emf. Then measure with a micrometer the diameter of the field wire and substitute in the following formula: $K = D^2/I$, where (D) is the diameter of the wire in thousandths of an inch and (I) the field current in amperes. The value of (K) should be about 800 to 1000 for safe temperatures. Another, and in some ways a better method, is to estimate the total outside area of the coils (A) and allow from 0.5 to 0.75 watts per square inch of surface to be dissipated. If the field resistance (R) is then measured, the allowable current is, $I = \sqrt{[(A \times .75) \div R]}$.

If more current is necessary than is allowable, then it will be best to use the series winding in parallel with the other winding. To do this it will be best to use the full allowable current in the series winding and take up the excess voltage in a rheostat. To determine whether this method is too wasteful, it may be advisable to use a water rheostat and adjust the field to full load and calculate the energy lost. If the arrangement is found too wasteful, it may be possible to use an extra set of brushes on the exciter or use some other lower voltage source to excite the series field. I would prefer any reasonable arrangement to avoid the use of the commutator on the machine itself. A more substantial job, in case the separate excitation field will not safely carry the load, would be to rewind the series field using a higher resistance wire and designed to parallel the first field coils.

Paralleling Shunt and Compound Wound D. C. Generators. Ans. Ques. No. 442.

The 100 Kw 220 volt compound and 50 Kw 220 volt shunt machines mentioned in question 442 can be paralleled. Adjust the shunt machine and its regulator and the compound machine so that their characteristic curves are as nearly alike as possible. For connections see Standard Handbook for Electrical Engineers. Parallel the shunt machine with the compound machine in the regular manner. No equalizer connection is required.

To compound a 25 Kw 110 volt generator proceed as follows: Load the generator to its full rated capacity and by separate excitation of the field, increase the current until the terminal emf is the value desired. Call this measured current (I). Then with the generator on no load, adjust the field current for no-load emf. Call this field current (I_0). Measure the resistance (R) of the shunt field at full load temperature. If (m) is the resistance per mil foot for the shunt coil wire, (a) the area in circular mils and (d_0) and (d_1) the outside and inside diameters of the field coils for any spool, then the number of turns on the shunt field can be found from the following formula: $T = (24 \times a \times R) \div [(m\pi\ (d_0 + d_1)]$.

Then (I_1 T) is the total ampere turns required. (I_0 T) is the no-load or normal shunt field ampere turns. Then (I_1-I_0) T is the ampere-turns required by the series field for the compounding.

The current for the 25 Kw at 110 volts is (25,000 ÷ 110) = 228 amperes. Then the turns required on the series field are, $(I_1 + I_0)\ T \div (228 \times P)$ = turns per coil where (P) is the number of poles. The remainder of the design must be left to the party asking the question, remembering, however, that full number of turns per coil cannot be used because the terminals are brought out at opposite sides, thus causing a half turn. From 800 to 1200 circular mils per ampere can be allowed to keep the heating under 40 degrees C, the higher value being used only when the coil is shallow. H. E. Weightman (Ill.)

Paralleling Compound and Shunt Wound D. C. Generators. Ans. Ques. No. 442.

Editor Electrical Engineering:

The 100 Kw compound generator and the 50 Kw generator may be operated in multiple if the Tirrell regulator is used with the shunt machine. The compound generator is wound so that its voltage is maintained constant for any current and the regulator on the shunt wound machine will hold its voltage constant so that no local currents will flow between the two machines. Fig. 1 shows the method of connecting.

There is no way to figure the series coils for the 25 Kw machine without detailed data on the size of armature, number of armature conductors, number of poles, type of winding on armature, etc. However, the following is a method of obtaining the desired results experimentally.

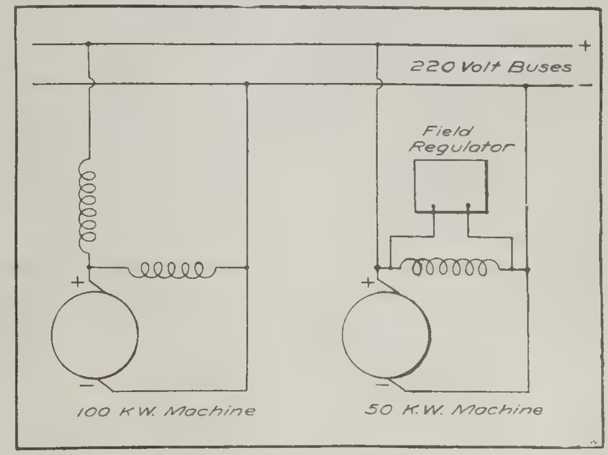


FIG. 1. CONNECTIONS FOR PARALLELING TWO MACHINES.

Full load current of 25 Kw machine at 110 volts is 25000/110 = 227.5 amps. Using a current density of 2,000 amperes per sq. in. cross section of the series conductor gives a cross section of 227.5 ÷ 2000 = .1137 sq. in. This area corresponds to about No. 2/0 B. & S. gauge wire. Wind as many turns of this size wire on the spool as it will accommodate, being sure that the current travels around the core in the same direction in shunt as in the series winding. This will cause the series coil to produce a magneto-motive force in the same direction as the shunt coil. Then shunt a variable resistance across the series coil in the manner shown in Fig. 2, with a water barrel or other form of rheostat in the circuit for a load according to the connections shown in Fig. 2. Here (V) is a volt meter, (C) a current meter and (A) is a rheostat. The current carrying capacity of (A) must be high enough to take about 50 per cent of the full load current without over heating and its resistance must be comparable with that of the series coil. A suitable resistance could be made by winding some heavy iron wire around a dry or paraphine soaked piece of 10 x 10 inch timber, and constructing a slide to make contact with the wire. The strength of the series field is varied by this rheostat till the E. M. F. is normal at full load current. The shunt should then be left connected to the machine at this value.

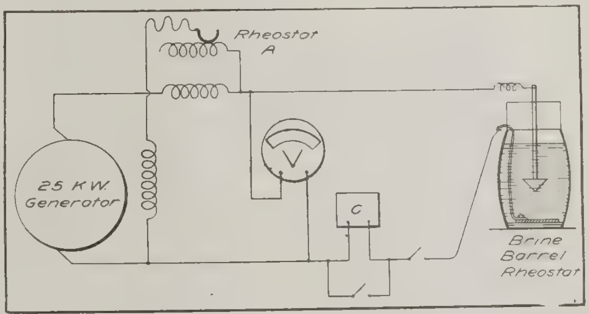


FIG. 2. CONNECTIONS FOR TESTING OUT A COMPOUND WINDING.

A. U. Avera, (Miss.)

Paralleling Compound and Shunt Wound D. C. Generators. Ans. Ques. No. 442.

Editor Electrical Engineering:

A compound generator can be paralleled with a shunt machine controlled by a Tirrill regulator, but the division of load will not be good under all conditions. The external characteristic of a flat compound generator is not a straight line, but rises slightly for a distance and then drops, passing through normal voltage at full load, and then falling below. A machine controlled by a Tirrill regulator has a characteristic which is practically a straight line.

If the machines are paralleled as in Fig. 2, several conditions may arise, depending on the no load and full load voltage of the compound machine. If the shunt on the series field of the compound machine is regulated so as to give 222 volts at no load, 220 at full load, and the Tirrill regulated machine gives 220 volts at all loads, the compound machine will pick up all load as it comes on until it reaches its rated capacity of 100 Kw, when the shunt machine will begin to pick up any additional load. The compound machine will hold its load of 100 Kw, and the shunt machine will take all load over this. If the load drops off, the shunt machine will drop its load entirely, before the compound machine begins to drop its load. These conditions will hold for no load voltage on the compound machine at or above 220 volts. If the no load voltage is below 220, the shunt machine will pick up all load, and will do so till it breaks down. It is necessary, therefore, to have the no load voltage of the compound machine at or above normal, and its full load voltage at normal, for paralleling successfully.

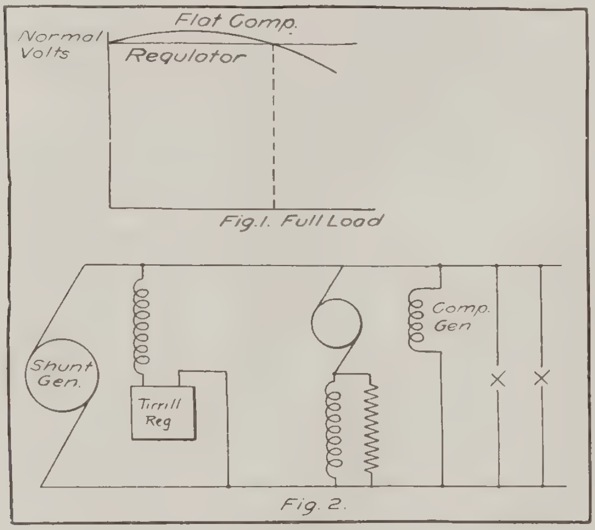


Fig. 1 and 2. Connections for Compounding Generators.

The simplest method of compounding a generator, if the number of shunt turns is not known, is by experiment. One good method is to wind a given number of turns of fairly heavy wire on every other pole. These will be like poles, and these windings should be connected in series so that none will be bucking. Have the machine running at rated speed, and the shunt field adjusted to give desired voltage at no load. Throw on nearly full load and pass current through the temporary turns from some other source, until voltage is at, say, about 5 per cent above normal with full load on. Now read the current in the temporary field, and multiply by the number of turns per pole. If (N) is the number of turns per pole and (i) is current, the number of series ampere turns per pole will be (Ni/2), since this winding was on only half of the poles. If the full load current of the machine is (I), the number of turns per pole will be (Ni/2I). A variable shunt will have to be used if the machine is to be flat or under compounded.

L. M. Klinefelter (Colo.)

Action of a Condenser. Ans. Ques. No. 446.

Editor Electrical Engineering:

The practical condenser consists of thin metal sheets separated by a dielectric, mica or parafined paper. One terminal of a circuit is connected to alternate metal plates while the other terminal is connected with the intervening metal plates. Whenever there is a difference of potential impressed upon the condenser terminals, stresses or electrostatic lines of force are set up within the condenser and by means of electrostatic induction these stresses are shown electrically by a counter electromotive force. During the establishment of these stresses, a current is flowing through the condenser known as the displacement current, which, however ceases to flow when the counter emf is equal to the impressed electromotive force and the condenser is then said to be charged.

The opposition to flow of current is quite different from that of a resistance. The practical resistance of a condenser does not obstruct the flow of current as a resistance is considered to do, but when the counter emf reaches the value the impressed emf the current ceases to flow.

Method for Connecting Instrument Potential Transformers. Ans. Ques. No. 438.

In regard to the connections shown by T. C. M., in Question 438, the connections shown here explain the action. In Figs 1 and 2 it will be found that the same connections are shown and that the emf supplied to the potential coils of the meter flows in opposition to each other, as indicated by the arrows. In Fig. 3 you have either connected both red or both black in the same manner together to form the middle tap or to the outside leads.

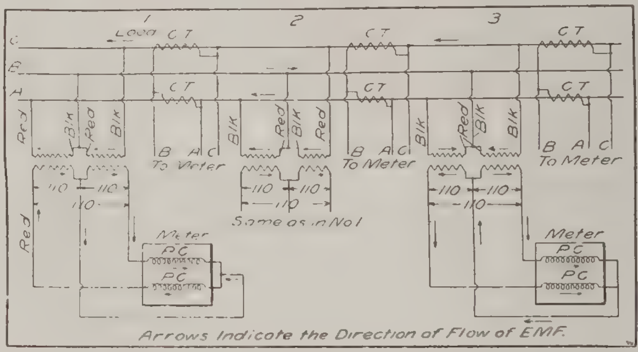


Fig. 1, 2, 3 and 4. Connections Showing Reason for Transformer Action.

You will find that among most large manufacturers of instrument transformers, it has become a practice to mark one terminal of both the primary and secondary sides. This indicates the instantaneous polarity of the two windings, and when these indications are not followed the meter will rotate in the wrong direction. You can reverse the direction of rotation of the meter by reversing the potential leads but this will not give you the correct registration of power expended.

The reason for one element of a polyphase meter reading low when each coil is connected separately is, that each element in itself is a single phase meter with drag or retarding magnets and the element connected has to take care of the effect of the magnets of the other element.

J. S. H. (Miss.)

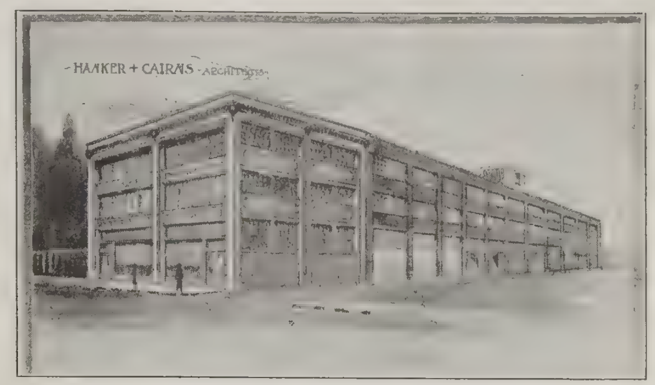
New Apparatus and Appliances

New Home of Electric Supply Company of Memphis, Tenn.

On August 1st or shortly thereafter, the Electric Supply Company of Memphis, Tenn., will move into the new three story and basement building shown in the accompanying illustration. This company is engaged in the jobbing of electrical apparatus and supplies, doing no retail or contracting business and is enjoying one of the largest and fastest growing trades in the states of Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Missouri and Arkansas. The company is owned and managed by Southern men and men who have grown up with the electrical business in the South. It is their policy to serve buyers of electrical equipment only and to provide arrangements and carry such stocks as to enable prompt shipments to all points in the territory named in any quantities. No hardware, mill or automobile supplies are therefore carried, all available capital being concentrated in the electrical jobbing business. A complete stock of the following lines is carried: Edison lamps, Phillips weatherproof and rubber covered wire, General Electric fans and wiring devices, Fort Wayne wattmeters and transformers, Columbia dry batteries, Standard electric porcelain, American telephones and Hotpoint heating devices. For the fan season the company has special arrangements for promptly handling all rush orders in large and small volume by reason of being able to draw on a large stock at Memphis and in addition on the General Electric stocks located at Cincinnati, Atlanta, New Orleans, St. Louis, Chicago and Kansas City.

Mr. W. R. Herstein, Secretary and Treasurer of Electric Supply Company, Memphis, Tenn.

The new home of the Electric Supply Company referred to above is being constructed of reinforced concrete and faced with glazed white tile. It is 36 by 250 feet and will face the tracks of the Southern Railroad on one side. The entire floor space will cover about two-thirds of an acre and in every department labor saving and fire-proof devices will be installed. The entire ground floor will be given over to warehousing purposes with a sufficiently ample arrangement for taking care of the demands of the Memphis electrical contractors, central stations, street railway and telephone companies. The executive and other offices will be located on the second floor.

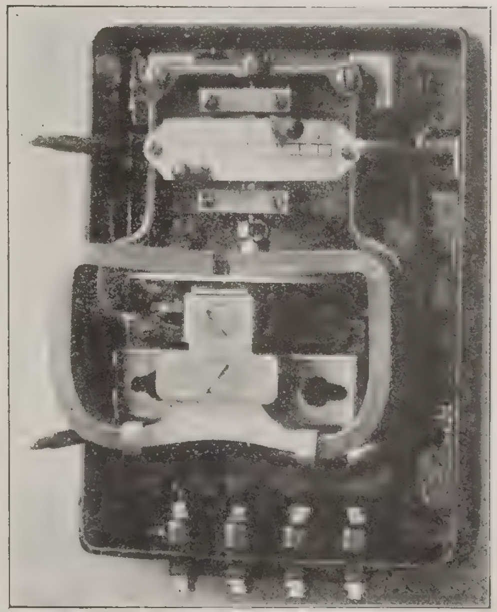


New Home of the Electric Supply Company.

Inverse-Time-Element Relays.

Alternating current reverse power relays close their contacts under conditions of overload or of reverse power. They are of three different characteristics each having the inverse time limit feature: (a) Overload and reverse power. (b) Overload only—instantaneous or adjustable definite minimum time at heavy overloads. Relays of this character are manufactured by the Westinghouse Electric & Mfg. Company and have operated satisfactorily under all conditions of service.

The accompanying illustration shows an overload-and-reverse power relay which in principle consists of contacts closed by an induction type alternating current instrument in which are combined the functions of ammeter and wattmeter, tripping at heavy overloads and on low reversed power. At zero voltage the relay acts as an ordinary current-actuated overload relay, and therefore low power factor or absence of voltage does not prevent it from tripping. The relay is operated from voltage and current transformers of 100 volts and 5 amperes secondary. Three adjustments



Overload Relay With Cover Removed.

are provided—one for regulating the ratio of the reverse to the overload tripping current, one for regulating the absolute values of these quantities, and the third for regulating the value of the time element. The relays can be adjusted to operate at from 6 to 14 amperes in normal direction and from 0 to 4 amperes reverse power with normal voltage.

The plain overload relays are similar in principle to the overload-and-reverse-power relays, but the voltage connection is omitted. The relay for reverse power only is a combination of the overload-and-reverse-power relay movement with a selective wattmeter element that keeps the trip circuit open when power is flowing in the proper direction. This removes the overload feature of the main relay and allows the instrument to close the circuit only on reverse power.

New Headlights.

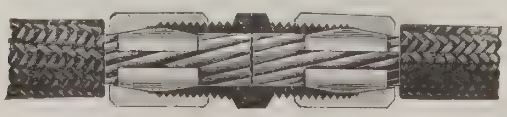
Two new types of electric headlights have been designed by the Esterline Company, Indianapolis, Indiana. These new headlights make use of the "golden glow" glass reflectors which characterize the Esterline Company's products. The lamp bodies and fronts are made entirely of pressed steel, and both water and dust proof. A metal ring which holds the reflector in place, also clamps a heavy gasket over which the front or door presses, making a very tight joint. Electric welded joints and fastenings are used instead of screws or rivets. After assembling, the lamp bodies are given several coats of baked enamel, inside and out, which renders them proof against rust.

THE GOLDEN GLOW HEADLIGHTS OF DASH AND RECESS TYPES.

As shown one type is made to recess into the dash of the car, while the other is for mounting on the front of the dash. These headlights project a non-blinding light of sufficient intensity to serve as a warning and for illumination under all weather conditions. Recent tests of these headlights fitted with a 36-watt lamp on a dark city street showed that the second hand of a watch could be read at a distance of 600 feet, and that, from the car, a man lying on the track can be seen further than is possible with an arc lamp.

Dossert Connectors.

A connector which forms mechanical connections without soldering, is shown in the accompanying illustration as designed and manufactured by Dossert and Company, 242 West Forty-first street, New York City. The merits of this connector are being recognized by engineers since it saves considerable time and labor in the erection of apparatus and affords easy facilities for disconnecting circuits in case of trouble or when temporary connections are required. The field of usefulness is a large one in power and substation wiring, including connections between cables, disconnecting switches, oil switches and busbars, generator, converter and transformer apparatus, motors, switchboard and control gear; sectionalizing cases for signal installations, car wiring and all shop and mine wiring, fuse block, rheostat, storage battery and other terminals.



DETAIL OF DOSSERT TWO-WAY CONNECTORS.

Dossert connectors will join or tap any combination of stranded and solid wires and cables, studs, rods, tubing and bolted contact surfaces at any angle. They will take conductors ranging in size from No. 14 wire to 2,500,000-cm. cable. A number of plants in the South have adopted the connector as a standard device in installation work, including Eagle and Phoenix Mills, Columbus, Ga., The Great Southern Lumber Company, the Southern Power Company, in its power plants and substations, the Texas Oil Company at Port Arthur, and others of a similar nature.

The Dumore Vacuum Cleaner.

The design of vacuum cleaners has had an interesting development. Many types have sprung up and disappeared due either to financial troubles or faulty design. In spite of these difficulties, the vacuum cleaner as a general proposition has "made good" and those companies who have produced cleaners of quality rather than cleaners of low price are to eventually profit by supporting this principle.

The illustrations shown here are those of a quality device, designed by the Wisconsin Electric Company, of Racine, Wis., both mechanically and electrically on an efficient and substantial basis. The makers of this cleaner claim that it is in a class by itself and we have no reason to doubt this from a consideration of the following details of design. Two fans are provided, one on each end of the motor shaft with the fans and armature of the motor balanced, thus tending to produce, smooth running, minimum noise and long life of bearings. The fan casing has a special snail

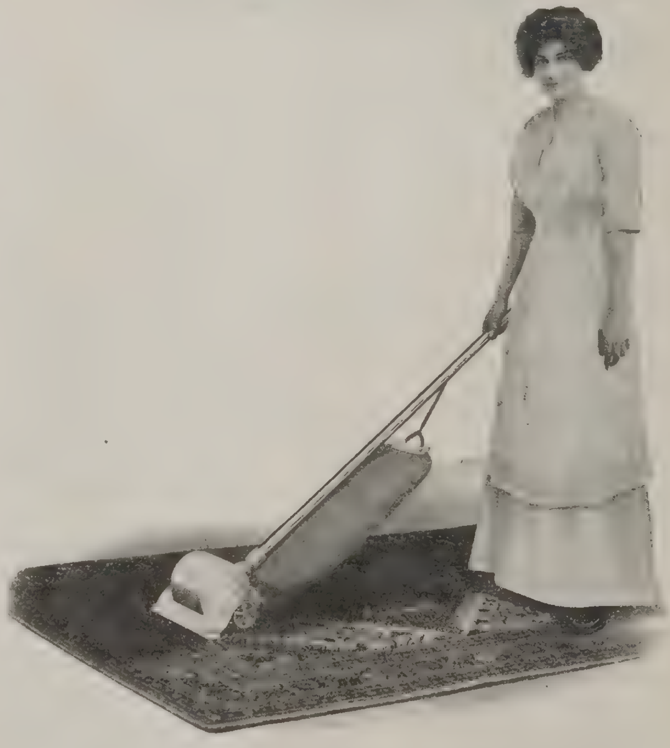


FIG. 1. THE DUMORE VACUUM CLEANER AT WORK.

case affording ample air space without the howl and lack of suction efficiency that is found in those types where due consideration is not given to the design of fan casing. This is an important point in cleaner efficiency. Another important feature of this cleaner is the use of a universal A. C. and D. C. motor, a matter which has considerable weight with the central station and electrical dealer who handles cleaners in a section where there is only A. C. or D. C. or a combination of both types of service. This motor is of ample size to handle a large volume of air and the cleaner is designed on this basis since the success of any cleaner in the main depends upon the volume and velocity of the air displaced. The hose used is 1½ inches in diameter, eight feet of which is furnished with ferrule and nozzle as well as four feet of tube and six other devices to adapt the machine to all kinds of cleaning.

A small hand cleaner is also made by this company that can be used for dusting off passengers in trains, customers in hotels, clubs, barber shops, etc. It can also be used to clean pool and billiard tables, seat cushions of carriages and automobiles. This device is made also in a type with curry comb for grooming stock.

These cleaners are not peddled from house to house, the policy of the company being cooperation with electrical dealers and the distribution of their produce through the established commercial channels of the electrical trade.

Pressed Steel Transformer Case.

A transformer case of pressed steel has been designed by the Pittsburgh Transformer Company, of Pittsburgh, Pa., which is intended for use with distributing transformers. It is claimed that these cases are much lighter and stronger than ordinary cast iron, an average saving in the total transformer weight of 30 per cent being claimed by the manufacturers. This means practically an average saving of 30 per cent in freight, and since transformers run into considerable weight, the cost for freight is a considerable item of expense, which the buyer of distributing transformers must directly or indirectly pay. While it is difficult to get accurate central station costs for the handling of such heavy material as transformers, fairly close estimates are made, and such estimates show that on 10,000 pounds of transformers shipped 500 miles the freight, cartage, loading, unloading, warehousing, installing, etc., cost about $110.00. Thus a 30 per cent decrease in weight saves $33.00. The weight reduction of 30 per cent is substantial enough to result in practical benefits to the central station in permitting larger transformers to be mounted on poles with the same pole-strain safety factor, or permits the use of smaller poles for given transformer sizes.

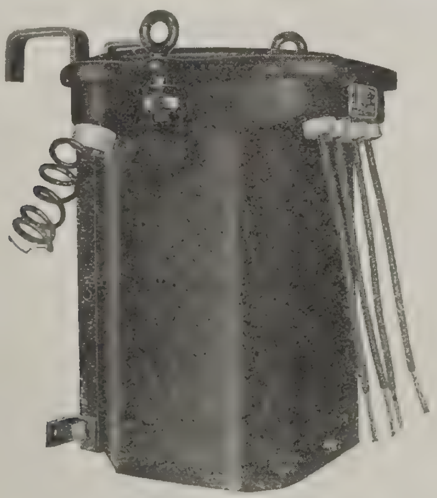
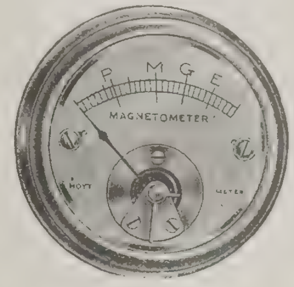


Fig. 1. A Pressed Steel Transformer Case.

It is claimed, further, that the new pressed steel case has been developed not only lighter in weight, but much stronger than cast iron, so that the new case will stand up even better to the every-day wear and tear, rough handling in transit, accidental jars such as sometimes happen when a transformer falls from a pole or wagon.

The Hoyt Magnetometer.

A type of meter suitable for use with an automobile magneto has been designed by the Hoyt Electrical Instrument Works, Penacook, N. H. This instrument is two inches in diameter and arranged for fastening to the dashboard of a car so as to indicate to the driver at all times just what the magneto is doing. It is now a standard piece of apparatus on Ford cars, being designed for the Ford magneto.



The Hoyt Magnetometer.

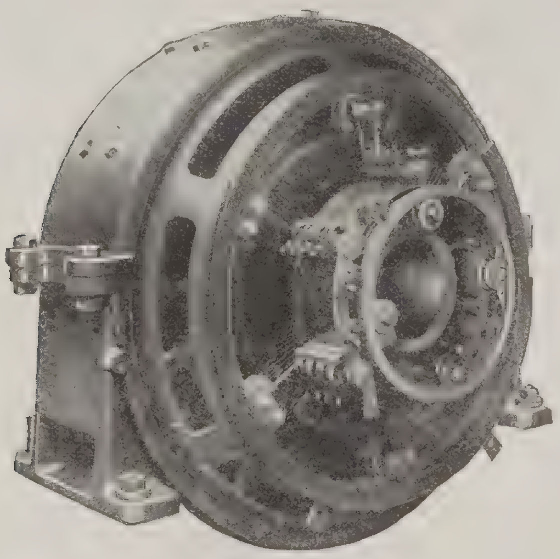
After an exhaustive series of tests made on Ford cars of all ages and conditions, it was found that almost invariably there was a point at which the magneto, although generating, did not satisfactorily ignite the charge at all times. This point is indicated on the scale as "P"—meaning poor. At still another point the magneto, while operating without skipping, ignited the charge so slowly that there was an appreciable lack of power. This is indicated on the scale as "M"—meaning medium. The lowest point at which efficient ignition took place was designated "G" for good, and excellent was indicated by the letter "E." The average of a number of cars tested gave the following results: Below 8 miles per hour, "poor;" 10 to 15 miles per hour, "medium;" 18 to 25 miles per hour, "good;" above 30 miles, "excellent." A very few cars showed "good" at 15 miles, but they were an exception.

The nature of the Hoyt magnetometer is shown in the above illustration.

Engine Driven 2 and 3-Wire D. C. Generators.

A new line of engine type, commutating pole, continuous current generators has been recently placed on the market by the General Electric Company in sizes ranging from 25 Kw. to 400 Kw., inclusive. They are manufactured in both the two-wire and three-wire types, with either shunt or compound field windings, and with armatures wound to deliver the rated kilowatt output at any voltage from 115 to 125 volts or 230 to 250 volts. Larger sizes of both types and wound for 250 volts only are built on specification.

A new feature of this line of generators is the development of the three-wire machines with a special type of revolving compensator. The advantages of the three-wire system for the distribution of electrical energy at low voltages are well understood. The principal advantage is the fact that a 125/250 volt, three-wire system requires about one-third the amount of copper in the distribution system required by a 125 volt two-wire system. Thus the adoption of the three-wire system for a combined lighting and power load saves about two-thirds the investment in copper. The adoption of the revolving compensator with one collector ring for obtaining the neutral connection with three-wire operation is somewhat a radical departure from previous designs. This design supersedes the familiar separate stationary compensator and two collector ring arrangement. The revolving compensator consists of a circular magnetic core, upon which are mounted suitable exciting coils, the core with its coils being assembled on a cast bracket bolted directly to the back end of the armature spider. The compensator fits under the overhanging end windings of the armature, projecting but a short distance beyond the main winding. The compensator windings are connected to the main armature winding at proper points, and the neutral connection is taken through the armature spider to a single collector ring mounted on the outer end of the commutator shell. The neutral brushes bearing on this ring are supported by and insulated from the main brush-holder studs.



General Electric Commutating Pole Engine Type Generator.

Revolving compensators may be applied and connected to standard two-wire armatures. Aside from the armature construction, the only important difference between a two-wire and a three-wire generator is in the field connections. In the three-wire generator the series and commutating fields are equally divided between the two sides (positive and negative) of the armature, insuring exact compounding for all load conditions, whether balanced or unbalanced.

A New Line of Graphic Meters.

A complete line of continuous writing curve drawing instruments has recently been completed and placed on the market by The Esterline Company, Indianapolis, Ind. These instruments are now furnished for the measurement of all electrical quantities, such as volts, amperes, watts, etc., with electric speed recorders, service recorders, pyrometers and graphic counters included. They are designed in switchboard rear connected type, wall or front connected, and portable types, with the general construction of all the same, with the exception of the case and the method of making connections. The clocks, meter elements and recording mechanism are also the same in all types.

These instruments are of the direct writing type, in which the pen is in contact with the paper at all times when writing. The ink supply is retained in a stationary well provided with a cover to prevent spilling of the ink when instruments are moved about. The clock is of the eight-day, jewel balance wheel type. It is provided with two driving springs, and a third spring which operates the rerolling device provided for winding up the finished chart. On some types the reroll is omitted and the finished record allowed to feed through a slot in the bottom of the case.

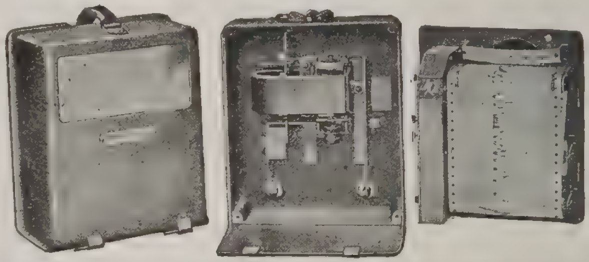


Fig. 1. Portable Meter With Cover and Clock Removed.

Meter elements are assembled complete in one unit and may be removed from the instrument without dismantling. For direct current ammeters and voltmeters a powerful D'Arsonval permanent magnet type movement is used. For direct and alternating current wattmeters, alternating current voltmeters and ammeters, a dynamometer type construction is employed. No iron is used in the magnetic fields of the dynamometer movements, so that meters of this type are accurate on all frequencies and respond promptly to voltage or load variations. The armature shaft of the meter element is provided with a bracket which carries pivots in which rest the pointer carrying the pen.

The power consumption on these instruments is so low that they may be operated from shunts or transformers already installed. Voltmeters and wattmeters require from 4 to 5 watts for each voltage element on 110 volts. Direct current ammeters consisting of millivoltmeters and shunts require only about one-third ampere for the instrument. Due to the direct writing construction, no extra control circuits of any sort whatever are made use of.

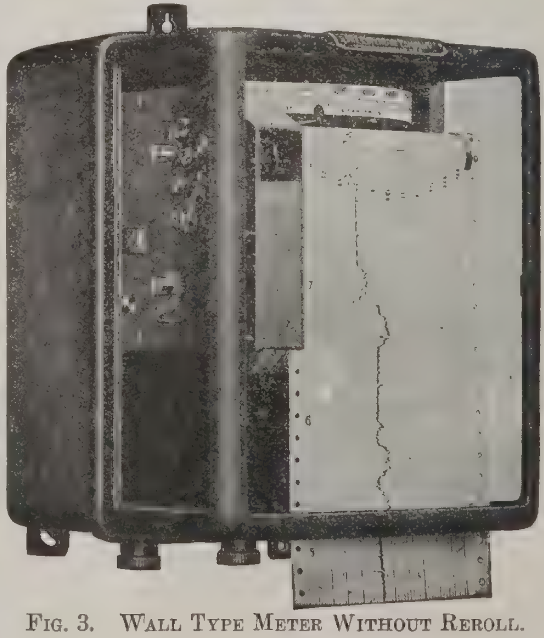
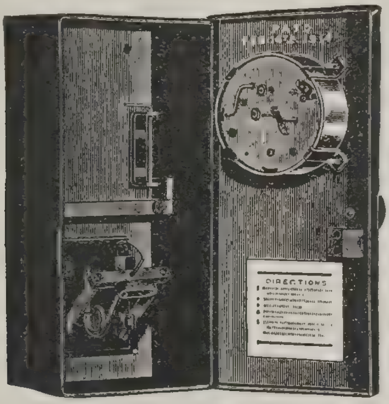


Fig. 3. Wall Type Meter Without Reroll.

These instruments may be used on switchboards for obtaining voltage and output curves. They may also be used for getting power consumption of motor-driven tools and for general efficiency engineering, and are especially valuable when it is desired to get an accurate record of power consumption in circuits where the load is fluctuating very rapidly.

The Commonsense Time Switch.

The accompanying illustration shows a type of time switch now being placed upon the market by the Kennedy-Webster Company, Chicago, Ill. This switch is designed to automatically interrupt a circuit according to a set schedule and includes a switch and clock mechanism which has a capacity of 30 amperes at 250 volts and is arranged so that it can be tripped or set by hand without opening the enclosing box. The clock is arranged so that an alarm hand throws the switch as in an ordinary alarm clock.



THE COMMONSENSE TIME SWITCH.

The switch mechanism is enclosed in a regular knock-out box with knock-outs on both sides and bottom so that it can be connected directly to rigid or flexible iron conduit and flexible non-metallic conduit from either the side or bottom by use of the proper bushings.

Greenwood Signs for South America.

The accompanying illustration shows several electric signs made up for the J. G. White Corporation, of London, by the Greenwood Advertising Company, of Knoxville, Tenn., for installation at Cordoba, Argentine, South America. This is the first of a series of installations of this nature to be made in the early future.

Electric Signs for Argentine, South America.

Electrical Construction News

This department is maintained for the contractor, dealer, manufacturer and consulting engineer.

ALABAMA.

GADSDEN. According to reports the Gulf State Steel Co., has made a contract with the Alabama Power Co., to furnish 3,000 horsepower to its steel mills at Gadsden. The mills will be re modeled so as to make use of electric motors at a cost of about $40,000.

HARTSELLS. It is understood that a franchise has been granted J. R. White to construct and operate an electric light plant.

OZARK. It is understood that new equipment is to be installed in the municipal lighting plant at this place, including a 200 kw. generator and engine. D. C. Darling is Superintendent.

FLORIDA.

MIAMI. It is reporsed that a real estate company, owned by Tatum Bros., is planning to construct a power plant to operate a street railway system.

GEORGIA.

CANTON. It is understood that an election is to be held to vote on bonds to enlarge the Municipal Electric Light & Water Works System.

CARROLLTON. It is understood that the city is having plans prepared for a municipal lighting plan tby McCormick & Sahy of Rome, Ga.

DARIEN. During the next few months the Darien Ice & Light CO., expects to purchase considerable plant equipment including meters, incandescent lamps and supply material.

EATONTON. An election will be held June 8th to decide on an issue of $25,000 in bodns to purchase and develop a water power at Griffin Mill and install an electric equipment. Information may be secured from M. A. Shivers.

LAWRENCEVILLE. It is reported that the city is to purchase poles and transmission line material, as well as tungsten street lamps of 100 to 200 candle power. Edward Carpley is City Electrician.

ST. MARY'S. It is understood that the St. Mary's Ice & Light Co., has recently been organized with a capital stock of $3,000 and will construct an electric light plant.

SAVANNAH. The Savannah Lighting Company is to install a switch board at its station and rearrange transmission and distribution lines. A new steam turbine and boilers with superheaters are to be installed as well as auxiliary apparatus and transformers.

WAYCROSS. The Ware County Light & Power Co., which has remodeled its power plant by installing a 500 Kw. steam turbine and boiler to take the place of gas producer outfit and gas engines, is to soon purchase a deep well pump of 500 gallons per minute capacity. H. C. Gamage is manager.

MISSISSIPPI.

GRENADA. The Supervising Architect, Treasury Dept., Washington, D. C., will receive bids until June 16th for mechanical equipment and lighting fixtures for a post office at Grenada, Miss.

RAMSAY SPRINGS. It is understood that the Ramsay Mineral Springs, which has recently been incorporated with a capital stock of $20,000, is planning to install an electric light plant and ice machinery. G. . McHenry of McHenry, Miss., is interested.

TENNESSEE.

COVINGTON. The Supervising Architect, Treasury Dept., Washington, D. C., will receive bids until June 13th for mechanical equipment and lighting fixtures for a post office at Covington, Tennessee.

MEMPHIS. It is understood that plans and specifications for a pumping station are now ready for bids. Equipment will include four centrifugal pumps of a capacity of 135,000 gallons per minute each, two centrifugal pumps of 45,000 gallons per minute each, and two priming pumps. The pumps will be motor driven. It is understood that the specifications call for a traveling crane, transformers, electrical wiring and extra piping. J. H. Weatherford is city engineer.

MEMPHIS. The Illinois Central Railroad Co., is to construct a steam generating plant at Memphis to operate elevators and furnish steam for heating cars in the yards at Memphis.

NEWPORT. It is understood that Z. L. Doughnour has been granted a franchise to install an electric lighting system. A hydro-electric plant will be built near Hartford.

WINCHESTER. The Supervising Architect, Treasury Dept., Washington, D. C., will receive bids until June 12th for mechanical equipment and lighting fixtures for a post office at Winchester.

PERSONALS.

MR. GEORGE A ORROK, mechanical engineer of New York Edison Company, delivered an illustrated lecture on "The Modern Central Station" at Georgia School of Technology, Atlanta, Ga. May 4.

WILLIAM L. STALEY, consulting engineer, has opened an office at 12-14 Cromwell Building, Albuquerque, N. M. Mr. Staley has been engaged in civil and mine engineering for 14 years, having worked in the coal fields of Indiana and Illinois for seven years and at ore mining, milling and irrigation power plant construction and surveying for over seven years in California and the Southwest.

H. C. SPAULDING has been engaded by the Society for Electrical Development to take charge of its news and advertising department. Mr. Spaulding is a graduate of the Massachusetts Institute of Technology, a member of the Technical Publicity Association, was formerly manager of the Thompson-Houston Co., afterwards manager of the electrical department of the Blake & Knowles Pump Co., and New England manager of Siemens & Halske Electric Co., assistant sales manager of the Triumph Electric Co., and district manager of the Yale & Towne Mfg. Co. Mr. Spaulding has had wide experience in publicity work and has been a frequent contributor to the Electrical World, Electrical Review and other technical papers.

Mr. Harry Chapin Plummer has been engaged by the Society to assist Mr. Spaulding in his department. Mr. Plummer has had several years' training in active newspaper work, has been a writer on engineering and technical subjects for technical papers, popular magazine, and daily newspapers. He has made a specialty of presenting in popular form subjects of an academic character.

MR. A. H. BOYD has resigned his position as manager of the Philadelphia Office of the Fort Wayne Electric Works of General Electric Co., to become general manager and treasurer of the Santo Manufacturing Co., Philadelphia, Pa. Mr. Boyd began work in the construction department of the Ft. Wayne Electric Works in 1899, and superintended the installation of many large and important light and power plants all over the country back in the days when this work was not sub-divided and systematized as it is today. In 1907 he was transferred to the sales organization and shortly after that was promoted to manager of the power sales department. In 1910 he was sent to Philadelphia to take charge of the district sales office and has held this position with great credit since. During the past nine months he has acted as receiver for the creditors of the Kellar Manufacturing Co., and when the Santo Co., was organized to take over the factories, equipment and business of the Kellar Manufacturing Co., he was quite naturally offered the position as general manager and treasurer. His successor as manager of the Ft. Wayne department of the G. E. Co., at Philadelphia has not yet been announced.

MR. DANA PIERCE, electrical engineer and agent at New York of Underwriters' Laboratories, sailed on May 2nd for England to visit the recently established London office of the Laboratories which is engaged in the examination and test of electrical and other goods made in England.

LOTZ & SCHEIBLE, consulting engineers and patent attorneys, at 332 South Michigan avenue, Chicago, Ill., announce that the growth of business has made it necessary to move into larger quarters at suite 1063 McCormick Bldg., 332 South Michigan avenue, Chicago. The firm members are Rudolph William Lotz and Albert Scheibel, and handle matters relating to patents, designs, trademarks and copyrights.

INDUSTRIAL ITEMS.

THE CONNECTICUT TELEPHONE & ELECTRIC CO., Meriden, Conn., announces the appointment of Chas. E. Stahl, of Chicago, as sales manager. This company manufactures a line of ignition specialties and electric lighting appliances for automobile and marine use. Mr. D. R. Peteet, 415-16 Fourth National Bank building, Atlanta, Ga., represents this company in the South.

THE ALLIS-CHALMERS MFG. COMPANY'S Atlanta, Ga., office has been moved to 1104-5-6 Healy Building from the Fourth National Bank Building.

THE RAILWAY AND INDUSTRIAL ENGINEERING COMPANY has recently moved its factory and main offices from Pittsburgh, Pa. to Greensburg, Pa. The manufacturing facilities at this point have been greatly increased. This company manufactures a very meritorious line of horn gap switches and out-door substations.

THE UNITED STATES LIGHT AND HEATING COMPANY of Niagara Falls, N. Y., has established a sales office at Washington, D. C., in the Evans Bldg., 1420 New York Ave., with Mr. W. G. Davis in charge. Mr. Davis, who was formerly connected with the U-S-L sales department at New York City. He will have under his direction the sale of U-S-L storage batteries, electric starter and lighter, and axle electric car lighting equipment in the territory including the states of Florida, Georgia, South Carolina, North Carolina, Virginia, Maryland, Delaware, and part of Pennsylvania.

GREENWOOD INDIVIDUALITY TRIUMPHS AGAIN

Wm. Randolph Hearst sent his Electrical Engineer from Atlanta just before the Big Shrine meeting to get a large electrical advertising display for his "Atlanta Georgian" and "Sunday American." In less than a week the sign went forward by Express, (an ordinary three weeks job) ready for the time needed, Monday, May 11th.

This recognition of electrical advertising by a potent factor in the newspaper world is overwhelming evidence of the results achieved by the use of Electrical displays.
Let us hear from YOU—Designs for the asking.

Greenwood Advertising Company

KNOXVILLE, TENNESSEE.

Western Plant at Los Angeles.

THE ROBBINS & MYERS COMPANY, Springfield, Ohio, recently broke ground for the construction of a new factory building to take care of a rapidly growing output. This building will be immediately south of and adjoining the new shops which were completed a little less than a year ago. The new building will be four stories and basement and will cover a ground area of 60 x 265 feet.

The Philadelphia office of the company has recently been removed from their old quarters, 205 Bailey Building to 606-608 Bellevue Court Bldg., 1418 Walnut Street.

THE GENERAL INSULATE COMPANY, 1008-14 Atlantic Ave., Brooklyn, N. Y., has started reconstruction on its plant recently destroyed by fire. The company expects to get all departments in operation in the reconstructed plant by June 1st.

THE H. W. JOHNS-MANVILLE CO., New York City, has recently installed indirect lighting fixtures in the Trianon Theater at New Orleans. This system replaces an elaborate system of direct lighting. Frink reflectors and a cove system of lighting have been adopted. purpose whatever.

THE UNITED STATES LIGHT & HEATING COMPANY, of 30 Church Street, New York City, announces that on May 20, the general offices were moved to the company's plant at Niagara Falls, New York. This transfer will result in bringing together the administrative, sales, engineering and production departments and will insure the most effective conduct of all in the interests alike of patrons and stockholders.

THE WESTERN ELECTRIC COMPANY announces that an alliance has been formed with the Conlon Washer Machine Company of Chicago, such that the entire line of the well-known Conlon electric washing machines will be marketed exclusively by the Western Electric Company under the trade name of the "Western Electric-Conlon." This selling arrangement involves no changes in the manufactory. Ample stocks will be carried at each of the twenty-eight Western Electric distributing houses located at shipping centers throughout the United States. The Conlon washer is well known to the electrical trade in general and is looked upon with particular favor by the central stations. Every moving part of this machine is enclosed. Belts or chains are not used as the motor is direct connected to the moving parts by a worm gear shaft drive. The Western Electric Company is planning a sales campaign, a feature of which will be a complete merchandising plan which will enable the central stations and electrical dealers to aggressively push the sale of this machine.

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Competition—What Is It?

Webster defines competition as the act of seeking or endeavoring to gain what another is endeavoring to gain at the same time, or the effort of two or more parties, acting individually, to secure the custom of a third party by the offer of the most favorable terms. Such definitions as these come to the mind of the average individual when the term competition is used. It is also usually considered that where competition does not exist a much-sought-after monopolistic condition rules. We do not intend to go into a discussion of the political economy of this question, but rather to call attention to a few common-sense suggestions that are in themselves definitions of the term competition as it is usually found in all lines of trade, and especially in the commercial side of the electrical industry, such as in the electrical jobbing, electrical contracting and supply business.

In a recent issue of a trade publication that has a habit of presenting pointed facts in a brief way, instead of an abbreviated arrangement of the dictionary on serious and trivial subjects after the fashion of most such mediums, a high note was struck in what follows:

"The average man in any business works blindly, going through the daily routine without really thinking—a process termed 'reflex action' by psychologists. The unusual man is ever alert to break away from the ordinary—to do new things in a new way. This is what makes him unusual, and this is one thing that makes him successful. You will notice that while others are crying 'competition' he is going ahead in his unusual way and succeeding. He has a monopoly, and to him competition is a phantom.

"Take the case of the electrical contractor. The writer knows from experience that it takes at least two hours to solicit and estimate a wiring installation for a cottage—say a $30 job. Probably seven or eight other contractors are figuring, for they are all eager for this kind of work. If this is the case, the contractor with a little prestige has one chance in five of getting the order. If he can get it at a price which will allow him to clear 10 per cent net, he is fortunate. He will probably get his money in ninety days. This is competition.

"The unusual man ignores this and pushes a specialty. With no more effort or time, he will solicit and land an order for show window equipment. He has no one to outguess; his profit is considerably over 10 per cent, and he gets his money almost immediately, leaving the decks clear for the next undertaking. Besides, he leaves a satisfied customer who will be influential toward another order. This man has no competition by virtue of his monopoly, and his monopoly consists simply in his being awake. To him competition is a phantom—the shadow of something that doesn't exist. The successful druggist, garage man, fruit vender, jeweler or shoemaker is getting ahead by the same tactics.

"The electrical game is one of the best, and it is getting better every day. Every new achievement of the laboratory opens new opportunities to the dealer. The laymen depend on him to keep them posted—they need the new things as they come out, and are willing to pay for them. Yet the average dealer absolutely refuses to see this opportunity. His only chance, as he sees it, is to do the old things in the old way, and his last cry will be that competition is so keen that he cannot make a living.

"All of the above is a very frank analysis of two types of men—the man who runs in a rut, who cannot see over the wall of prejudice, and who is haunted by the phantom; and the man who moves about with his eyes open. The pitiable condition of the willfully blind man only makes the achievements of the other type easier."

From what has been said, is it not plain that competition may be, and in fact usually is, found to be the scramble of a lot of fellows for undesirable business—a grabbing at the shadow of something that does not exist? Monopoly, on the other hand, while a much used and abused term, is realized in effect by the fellow who digs up new and original ways of efficiently doing things and studies his business in such a way that he knows how and when to step in and get an order with a profit while his competitors are scrambling over and securing orders without the profit. The name of the party who originated this view of competition and monopoly and the medium referred to are worthy of acquaintance, and an introduction can be furnished if desired.

Impressions of the Thirty-Seventh N. E. L. A. Convention.

An observing visitor at the recent Philadelphia convention of the National Electric Light Association was impressed with two things aside from the business nature of all procedure: First, with the spirit of harmony which pervaded all speech and action; and, second, the cordial relations between delegates, guests and visitors as they met in lobby, convention floor or roof garden exhibits. If we accept the statement by Elbert Hubbard, that the badge of sanity is the ability to co-operate, then surely the convention delegates need not worry about mental breakdown.

The work of the association, as shown in the abstracts and discussions of the various papers found elsewhere in this issue, represents careful investigation, serious thought and hard work by the best men, executives and engineers interested in central station work today and in the future. The conclusions of all committees, while not presented as final, represented the judgment of those equipped to speak in the light of and from actual experience, and in many cases opened up new fields for further investigation and discussion. The discussions on reports and papers were free and frank, and while some conclusions of committees were frequently criticised, yet in most cases the criticisms were in the form of helpful experiences or pertinent suggestions. On some points there were decided convictions, yet the rabid revolutionist and the ultra conservative were both noticeably absent.

In reference to the much-discussed question of state regulation, there seemed a universal willingness of the central station operators to fall in line with the new order of things. The members of the Public Service Commissions were spoken of in terms of highest respect, and the feeling prevailed that they were not only safeguarding the interests of the public, but of utilities as well, and that a policy of frankness would lead to a satisfactory solution of the problems which now involve the industry.

The work of all committees was well done. The arrangements were eminently satisfactory, the accommodations ample and the facilities for registration, information and entertainment excellent. All routine showed touches and results of previous experiences in getting together central station men for work and pleasure without serious interference the one with the other.

The standing of National Electric Light Association conventions was clearly evident through the presence of such men as Thomas A. Edison, Dr. C. P. Steinmetz, Chas. F. Bush, Frank J. Sprague, E. W. Rice and Samuel Insull and a registration of some 4,000 less distinguished but equally important individuals of responsibility in electrical affairs throughout the United States.

Official Opening of 30,000 Horsepower Plant Near Columbia, S. C.

The Parr Shoals Power Company's 30,000 horsepower hydro-electric development near Columbia, S. C., recently completed by The J. G. White Engineering Corporation of New York, and described in the April issue of Electrical Engineering, was officially opened May 30 with much ceremony and a great deal of enthusiasm, Mr. E. W. Robertson, president of the power company, acting as the host. The completion of this development marks an epoch in the industrial development of Columbia, where natural facilities and fine location waited only for the introduction of cheap power to boom the city's enterprises.

August Convention of Southeastern Section of N. E. L. A.

Plans for the August convention of the Southeastern Section of the National Electric Light Association, to be held at the Isle of Palms, near Charleston, S. C., August 19 to 21, have practically reached a definite form. President T. W. Peters, of the Columbus Railroad Company, and E. S. Roberts, of the Savannah Electric Company, have arranged a most interesting program, including eight papers on topics which have been little discussed by southern central station men. These papers include the following: Recent Developments in Incandescent Lamps; How, Where and When (a paper on relations with the public); Debts to the Customer and the Stockholder; The Central Station's Greatest Opportunity—the Electric Vehicle; Technical Considerations of Regulation; Selling Electricity to Municipal Plants; Commercializing Electrical Advertising; and Group Management of Small Central Stations.

During the three days of the convention, four working sessions will be held, two papers being assigned to each session so as to permit a full discussion on the topics presented. The first session will be held on Wednesday afternoon, the 19th; the second, Thursday morning; the third, Thursday night; and the fourth, on Friday morning. This leaves Wednesday afternoon for a boat ride to Fort Sumpter and the Navy Yard, and Friday afternoon for an automobile ride. Since the Isle of Palms is one of the best of southern summer resorts, the convention should be well attended, as it combines opportunity for work and entertainment under most favorable circumstances. This fact has been recognized by those responsible for arrangements, for the convention dates will enable members and guests to spend the week end, as the convention closes on Friday

spend the week end, as the convention closes on Friday.

Tallulah Falls Development of the Georgia Railway & Power Company

BY C. E. BENNETT, ELECTRICAL ENGINEER WITH C. O. LENZ, CONSULTING ENGINEER, NEW YORK CITY.

Section 3. Transmission System and Telephone System.

In the May and June issues of *Electrical Engineering* the hydraulic and electrical details of the generating station and substations of the Georgia Railway & Power Company were described. In what follows the details of the transmission lines and telephone system are presented.

The transmission system consists of a main No. 4/0, two circuit, 110,000 volt, steel tower line from Tallulah Falls to Atlanta, a distance of 90 miles, terminating at the Atlanta (known as The Boulevard) substation. From this point two No. 2/0, two circuit, 110,000 volt lines are constructed, one in a southern direction to Newnan, Ga., a distance of 50 miles, and in a northwestern direction to Lindale, Ga., near Rome, Ga., a distance of 80 miles. The line to Newnan passes through East Point, College Park and Fairburn, Ga. The line to Lindale is built by way of Marietta, Cartersville and Rome, Ga.

The main line from Tallulah Falls to the Atlanta substation is constructed with six No. 4/0 copper conductors and two 7/16th inch, 7 strand, galvanized ground wires, the latter mounted on the top crossarm of the towers. Special No. 4 copper clad wires are used for the telephone circuit, which is strung on the bottom crossarm of the towers. The lines from Atlanta to Lindale and to Newnan are constructed with double No. 2/0 copper circuits of the same type of construction as used on the main line. The insulators used are all of the suspension type. On the main line from Tallulah Falls to Atlanta four two-part insulators are used in series, made by the R. Thomas & Sons Company, of East Liverpool, Ohio, while on the remainder of the circuits five 10-inch disks, made by the Ohio Brass Company, of Mansfield, Ohio, are used. The copper strand is made up of seven hard drawn wires and a center wire of soft drawn copper.

TRANSMISSION LINE TOWERS.

The towers used for the 110,000 volt system are of three types—66, 70 and 80 feet high, of the American Bridge design, spaced about 17 to every two miles. The first or 66-foot type was designed for the No. 4/0 circuits of the main line; the second for the 2/0 circuits to Newnan and Lindale, Ga., while the third carries the high and low tension circuits around the outer zone of Atlanta. On account of physical conditions of the right-of-way, a few 105-foot towers were required. The spacing of the 110,000 volt line wires on the towers is 9 feet between centers, with one circuit on each side of the structure suspended vertically. The weight of No. 4/0 towers is 5,554 pounds, that of 2/0 towers 4,721 pounds, and of the special towers 2,000 pounds. The bases of the towers are 16 feet, 20 feet, and 18 feet 6 inches, respectively. The crossarms are of standard channel-iron section and the tower legs angle-iron section. The suspension insulators are carried from the crossarms by special U bolts. Tower footings are made by extending the tower corner angles into the ground to a depth of about 7 feet, with footing angles bolted to the bottom end. Besides the standard towers are special angle-towers for line angles above 10 degrees. These towers are of the same design as others, but of heavier section and with eccentric crossarms to take care of clearance for angle location. The weight of the 2/0 type is 6,680 pounds and that of the 4/0 type 6,880 pounds.

The towers for the transmission lines were designed and built by the American Bridge Company, of New York, from specifications furnished by Charles O. Lenz, Chief Engineer both of the Georgia Railway & Power Company and the Northern Contracting Company, the general contractor for the work. In all there are 1,754 towers, 816 of these being standard for branch circuits, as mentioned, and carrying six line conductors of 2/0 copper wire and two 3/8 inch galvanized steel strand ground wires.

SPECIFICATIONS FOR LINE TOWERS.

In view of the fact that the design of towers has received special attention, and interesting tests performed on them, a few of the important details governing their final design is given here. The loads for which they are designed are: (1) A longitudinal pull of 3,000 pounds at right angles to the end of any one crossarm. (2) A vertical load of 1,200 pounds at the ends of any or all crossarms. (3) A load of 1,200 pounds pulling in any direction at the top of the tower. (4) A load of 8,000 pounds pulling at right angles to the line or parallel to the crossarms—that is, 2,000 pounds at each crossarm. At the same time a pull parallel to the line or at right angles to the crossarms of 5,000 pounds—that is, 2,500 pounds in the same or

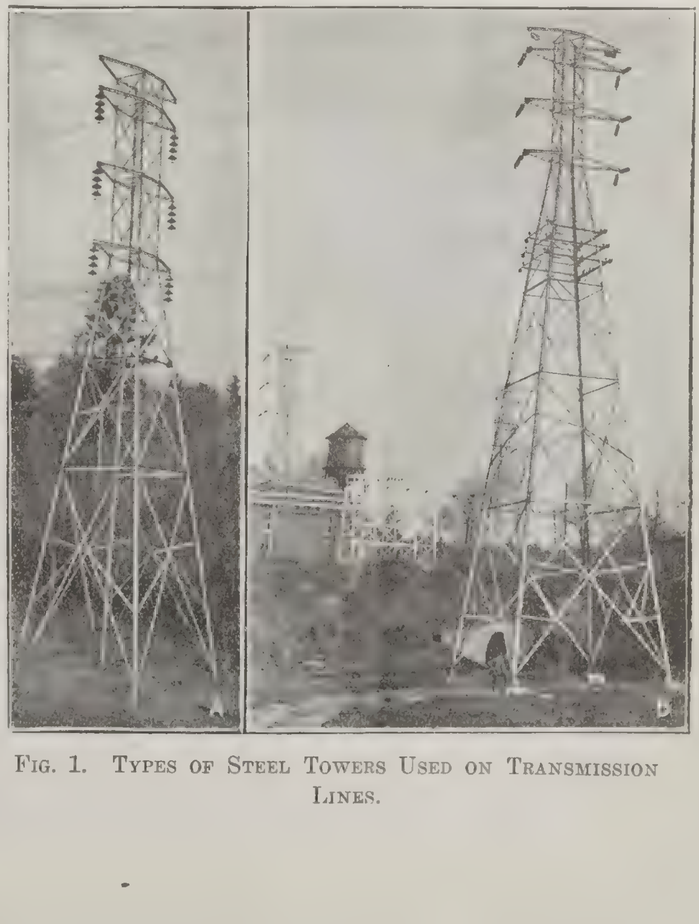


Fig. 1. Types of Steel Towers Used on Transmission Lines.

opposite directions at each end of any single crossarm or at one end of any two crossarms.

The crossarms are proportioned for a combined loading of (1), (2), and 1,000 pounds horizontal thrust at end of the arm. The tower is proportioned for maximum combination of (2) and (3) or (2) and (4). Unit stresses used were 25,000 pounds per square inch net for tension and $(25{,}000/[1 + (L^2/18{,}000\ r^2)]$ for compression.

The 753 standard towers for main circuits, carrying six line conductors of 4/0 copper wire, and two 7/16 inch galvanized steel strand ground wires, are 20 feet square at the base, 5 feet square at the top, and 66 feet to the upper crossarm. The number and arrangement of members are the same as in the 2/0 tower. The loads for which they are designed are: (1) A longitudinal pull of 4,300 pounds at right angles to the end of any one crossarm. (2) A vertical load of 1,500 pounds at the ends of any or all crossarms. (3) A load of 1,500 pounds pulling in any direction at the top of the tower. (4) A load of 10,000 pounds pulling at right angles to the line or parallel to the crossarms—that is, 2,500 pounds at each crossarm. At the same time a pull parallel to the line or at right angles to the crossarms of 8,000 pounds—that is, 4,000 pounds in the same or opposite directions at each end of any single crossarm or at one end of any two crossarms. The combination of loadings and unit stresses are the same as for the towers with 2/0 wires.

In addition to the above standard towers, there are 100 special 2/0 towers, 80 feet high, carrying, in addition to the 2/0 wires, six 4/0 wires; 15 angle towers, 66 feet high; 54 angle towers, 70 feet high; 23 angle towers, 80 feet high; and 10 angle towers, 105 feet high. All the towers were fabricated at the Shiffler Plant of the American Bridge Company in Pittsburg. The material was thoroughly galvanized, except the bolts, which were sherardized, and all material shipped "knocked down," the assembling at the site and the erection being done by the Northern Contracting Company. The concrete anchorages for all towers had previously been set by the same company.

Tests were made on both the standard 2/0 and the 4/0 towers, the tower being erected complete and tested for vertical, horizontal and torsional loadings. Referring to the 2/0 tower of Fig. 3, the following tests were made:

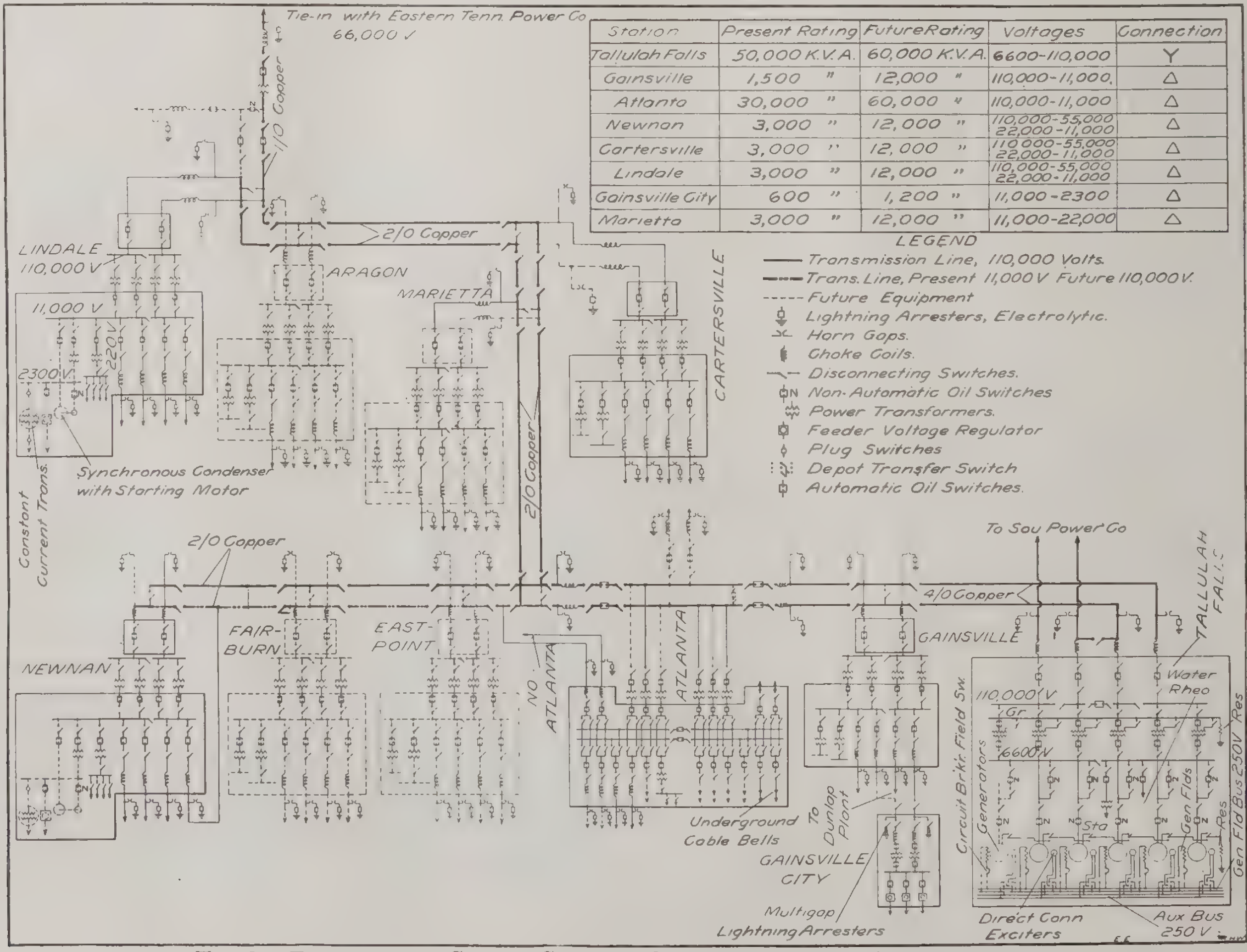
Test 1. A load of 1,200 pounds was placed in turn upon the right-hand end of each crossarm. The total deflection at the top of the tower to the right due to the four loads was ½ inch.

Test 2. An additional load of 1,200 pounds was placed upon the left-hand end of each crossarm. The top of the tower returned to within ⅛ inch of its original position.

Test 3. With the eight vertical loads remaining on the tower, a horizontal load of 2,500 pounds was applied at one end of the upper crossarm, pulling at right angles to same. A torsional deflection of ¼ inch was read.

Test 4. Tower was loaded as for Test 3. An additional horizontal load of 2,500 pounds was applied at the other end of the upper crossarm. The result of the 5,000-pound horizontal load was to deflect the tower 1½ inches.

Test 5. With the vertical loads remaining on the tower as for Test 2, a horizontal load was applied at one end of the lower crossarm, but caused no deflection.



Station	Present Rating	Future Rating	Voltages	Connection
Tallulah Falls	50,000 K.V.A.	60,000 K.V.A.	6600-110,000	Y
Gainsville	1,500 "	12,000 "	110,000-11,000.	△
Atlanta	30,000 "	60,000 "	110,000-11,000	△
Newnan	3,000 "	12,000 "	110,000-55,000 22,000-11,000	△
Cartersville	3,000 "	12,000 "	110 000-55,000 22,000-11,000	△
Lindale	3,000 "	12,000 "	110,000-55,000 22,000-11,000	△
Gainsville City	600 "	1,200 "	11,000-2300	△
Marietta	3,000 "	12,000 "	11,000-22,000	△

FIG. 2. TRANSMISSION SYSTEM SHOWING SUBSTATIONS AND ARRANGEMENTS.

Test 6. This was the destruction test. With a horizontal pull of 20,000 pounds at the intersection of the upper crossarm and the basket portion of the tower, one of the 4 x 4 x ¼ angle legs of the tower buckled about 12 feet from the ground.

A 4/0 tower was tested some weeks after the test of the 2/0 tower, with the following results:

Test 1. Vertical loads of 1,500 pounds were applied at each end of each crossarm. With the loads on one side, the top of the tower deflected ¼ inch. With loads at both ends of each crossarm, there was no deflection.

Test 2. All vertical loads remaining, a horizontal load of 2,500 pounds was placed at the end of the upper crossarm, pulling in a direction parallel to the crossarm. A deflection of ¾ inch was measured.

Test 3. A horizontal load of 4,300 pounds was applied at one end of the crossarm next to the upper one (3 feet 4 inches from top crossarm of the tower), pulling at right angles to same. The deflection at the top measured ¾ inch. When this load was increased to 8,600 pounds, the deflection measured 1⅝ inches. When load was removed, the tower returned to within ½ inch of its original position.

Test 4. This was the destruction test. With a horizontal pull of 14,000 pounds at the intersection of the upper crossarm and the basket portion of the tower, a deflection of 4½ inches was noted. This pull was increased to 25,000 pounds when the deflection was 10 inches. With a pull between 25,000 pounds and 27,000 pounds and a deflection of 10⅜ inches, the tower failed by one of the 4 x 4 x ¼ angle legs buckling about 40 feet from the ground near the intersection of the inclined portion with the basket portion.

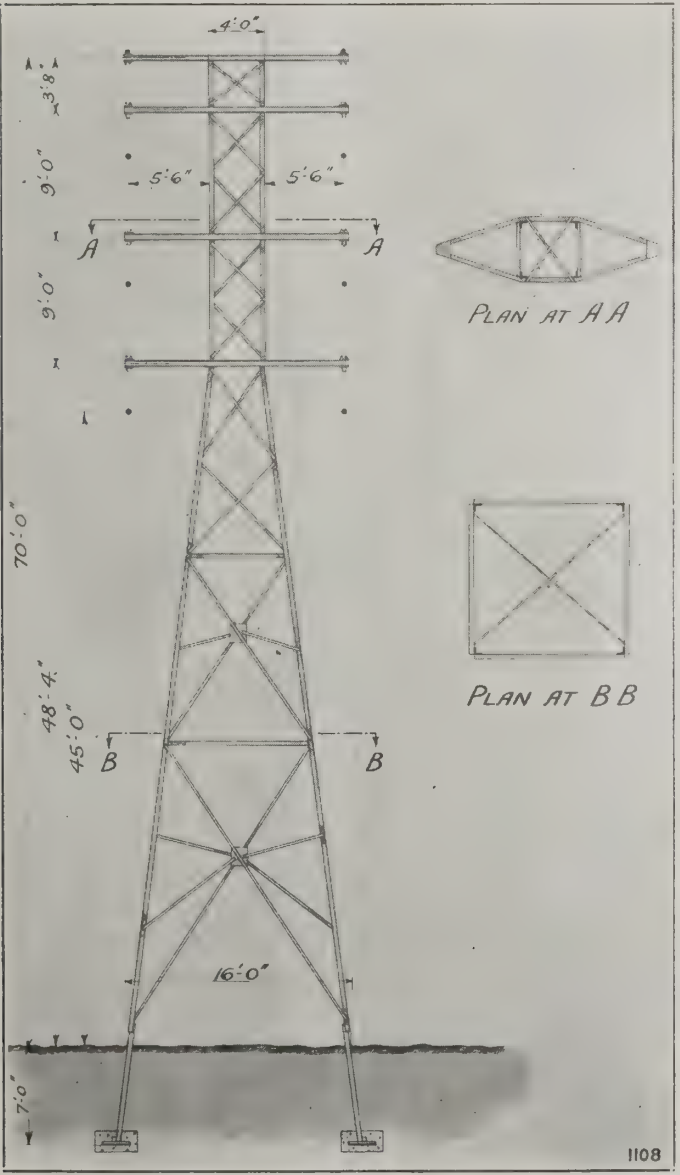


Fig. 3. Dimensions and Type of 2/0 Steel Tower.

THE TELEPHONE SYSTEM.

On the steel tower transmission lines throughout the system, a one circuit, two-wire telephone line is strung, connecting the power house at Tallulah Falls with all of the substations. This telephone line is constructed of No. 4 copper-clad steel wire, of 30 per cent conductivity, and the wires are strung on suspension type insulators of one unit each from the lateral tower bracing about ten feet below the lowest power conductor. By means of a specially designed clamp, hung from the insulator hook, the telephone wires are dead ended on each side of and transposed at every tower, the transposition being effected by crossing the loops in the two wires between the strain clamps on either side of the tower, one loop being given more slack than the other. This method makes it unnecessary to cut the wire and gives a thorough running transposition with the minimum number of joints. The wire is made from special large ingots so as to get lengths of one-half mile or longer. The required splicing is done by the use of 7½-inch copper sleeves. Mention is made of these facts for the reason that the essential points of a telephone system are high conductivity, small number of joints, and high insulation with balanced electrical characteristics. The large size of wire used also furnishes the mechanical strength necessary in stringing the wire with spans equal to the tower spacing to prevent excessive tension under severe load conditions due to ice and wind.

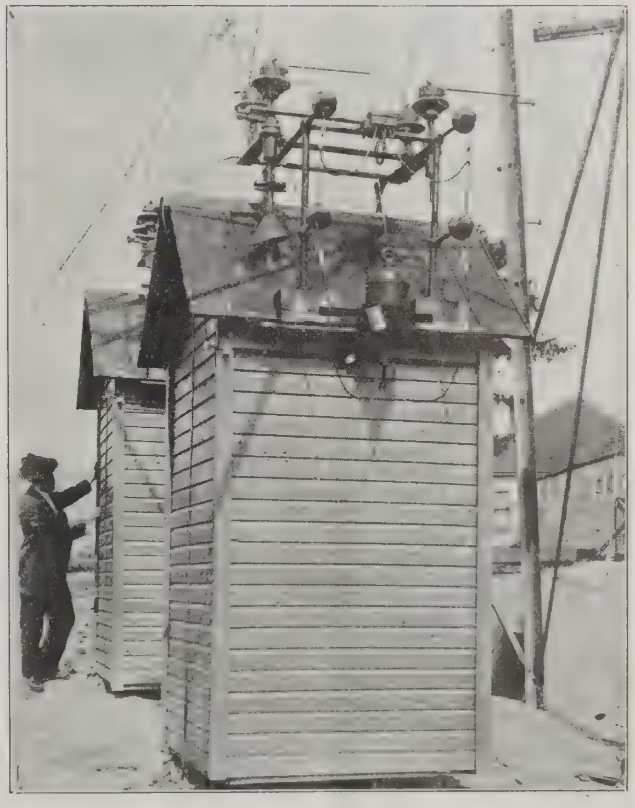


Fig. 4. Telephone Booth Installed Along Transmission Line.

TELEPHONE BOOTH EQUIPMENT.

The accompanying photograph, Fig. 3, shows one of the standard telephone booths. These booths are located every four miles along the line, or about every thirty towers. It is simply a wooden frame building about 4 feet square, with a specially constructed 22,000 volt switch on the roof. This switch is made with horn gaps to ground set at approximately ⅜ inches, and the two poles operated simultaneously by means of a hand lever inside the telephone booth through a vertical pipe shaft. Inside the booth is an insulated platform, on which the operator may stand while closing the switch by moving the hand lever to the left, thus cutting the station in multiple with the line. As soon as he finishes his conversation, the switch is again opened, cutting the telephone from the line. It is apparent from the foregoing that the telephones in the booths along the lines are not connected to the line, except during the

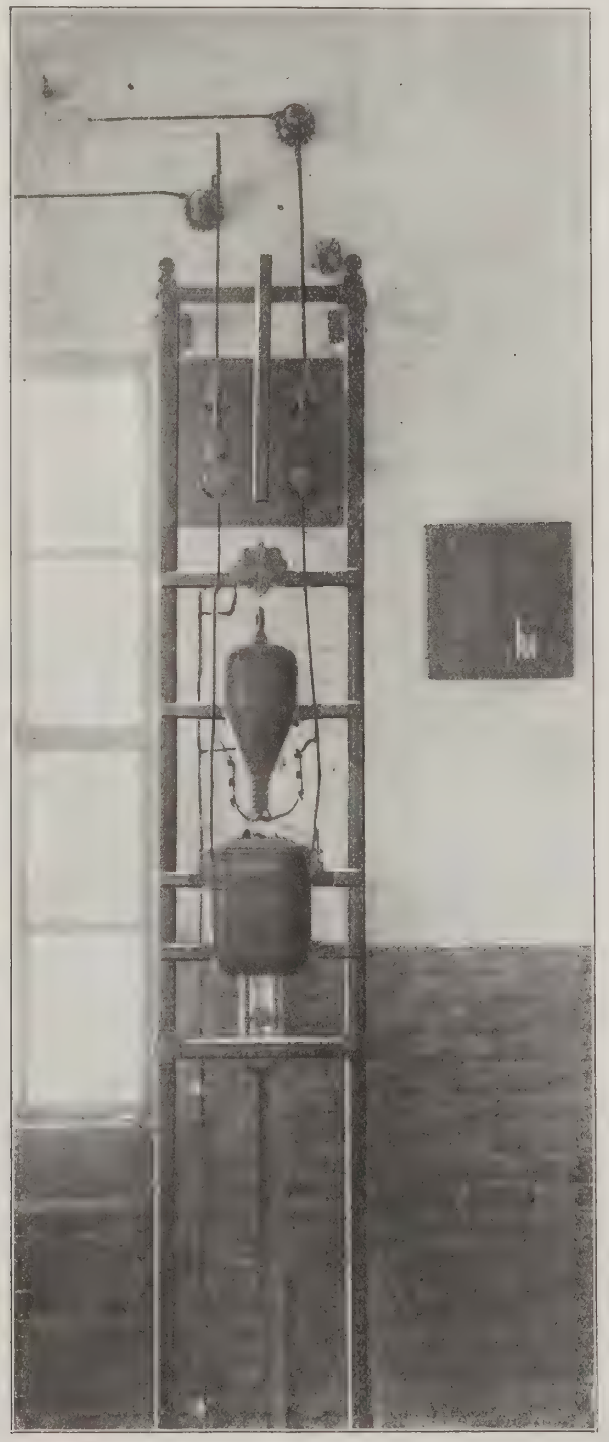


FIG. 5. LIGHTNING PROTECTION FOR TELEPHONE BOOTH.

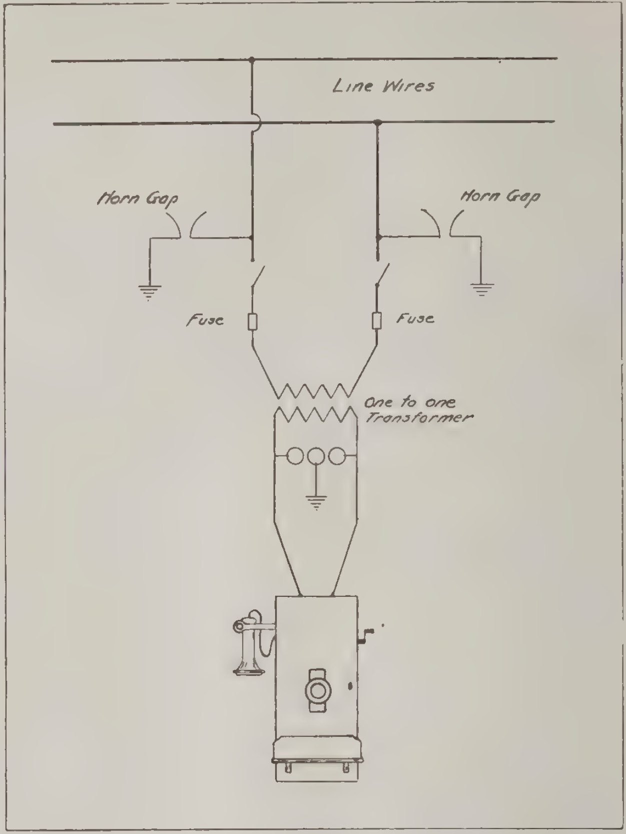


FIG. 6. TELEPHONE CIRCUITS AT LINE BOOTHS.

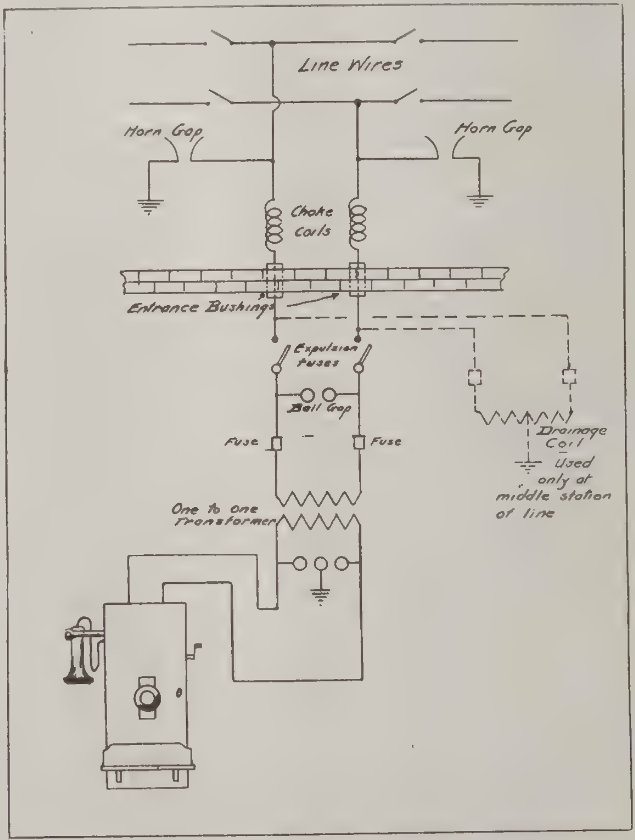


FIG. 7. TELEPHONE CIRCUITS AT STATIONS.

time they are in actual use, and the equipment is, therefore, not endangered by surges or lightning along the line, nor is the talking of the circuit impaired by having a number of stations in multiple with the line at all times.

At numerous places along the line convenient to working crews, the telephone line is sectionalized to facilitate the location of trouble. At the intermediate substations 22,000 volt, double pole switches are used for this purpose.

TELEPHONE SUBSTATION EQUIPMENT.

There is installed between each of the telephone lines and ground just outside of the substation building a horn gap, and close to this gap a choke coil of about fifty turns. The lines are then carried into the building through double type entrance bushings to a G. E. 7,500 volt, double pole expulsion fuse. On the inside of this fuse there is connected between the two lines a small ball gap, so that, should one of the lines become grounded, a discharge will take place across this gap and reduce the potential on both telephone lines without endangering equipment connected thereto. About the mid-point of the line there is connected between the two wires and ground a drainage coil. This is nothing more than a 15 Kw. 2,400/1,200—240/120 volt transformer with open secondaries and the mid-point of the primary windings connected to ground. It was necessary to use a large transformer to provide the necessary current-carrying capacity and with enough inductance to prevent the talking circuit from being impaired.

When the drainage coil is not connected across the lines, the induced potential on the telephone wires to ground with one circuit of the transmission line charged is about 5,000 volts. The use of the drainage coil makes it possible to reduce this voltage to about 300 volts.

Philadelphia Convention of the National Electric Light Association.

THE Philadelphia convention of the National Electric Light Association, held June 1st to 5th, has now passed into history, with particular features of interest due to conditions and circumstances attending recent progress of electrical industries and the experience of thirty-six other meetings that have gone before. The attendance, considering the geographical location of the meeting place, was normal, being around 4,000. Aside from this fact, important as it is in estimating the success of the gathering, two other facts come to the minds of those who regularly attend the sessions of these conventions—first, that members took every opportunity to voice opinions, freely object to those of others, present experiences and make suggestions, never before possible, or at least decidedly hindered, due to a crowded program. This year the number of papers scheduled for any meeting was held down so that they would tend in no way to shorten discussions. The judgment of those responsible for the arrangement was fully vindicated in the way the plan worked out, as shown in the report which follows. The second feature referred to was the nature of exhibits by manufacturing companies. Figs. 1 and 2 show the arrangement and character of booths. Very little heavy apparatus and equipment was on display, the booths being arranged in such a way as to suggest a visit on account of real interest rather than a curiosity to learn why the wheels go around. One large manufacturing company, the Wagner Electric & Manufacturing Company, occupied large space, without visible appearance of any commercial purpose, with the exception of the display of the company's trademark. During the entire convention the booth was seldom free from a crowd of visitors, and the company's representatives were kept busy as a reception committee. It is altogether probable that the success of the arrangement and layout of the booths at Philadelphia this year will decidedly affect the nature of future exhibits.

In what follows abstracts of papers and discussions are presented, arranged according to the natural department divisions of the industry as taken up in general, technical, hydro-electric, commercial, accounting and public policy sessions.

General Sessions.

Regular convention work began promptly at 10 o'clock Tuesday morning, June 2nd, with President J. B. McCall presiding. Hon. Rudolph Blankenburg, mayor of Philadelphia, welcomed the members and guests to the city with most cordial remarks and interesting comments on electrical development in Philadelphia. Following this address, President McCall delivered the president's annual address, in which he reviewed the work of the year.

Reference was made to the membership growth during the year, the total membership at present in all classes being 13,016. The decided increase in membership has been among individual Class B members, which now totals 10,817. President McCall showed that the commercial and company sections have had a remarkable growth and consequently demand a broadening of the executive organization of the association, the change at last year's convention providing for four vice-presidents being a decided help.

A modification of the work to be done at national conventions was referred to as supported by a number of members, in which the idea maintained is to confine the annual meetings to a few representatives from geographical sections, these delegates to consider broad policies. The technical, commercial and other details that are now handled at conventions could then be taken care of at state conventions. No recommendation, however, was made in regard to this matter.

Reference was made to the work of the public policy committee in dealing with broad questions affecting relations with the public and with other public service organizations. In regard to regulation matters, President McCall said:

"We cannot help but appreciate the foresight of this committee in its recommendations to the National Electric Light Association in favor of properly constituted supervision and regulation in the industry."

In regard to governmental control, President McCall said that the principle of governmental regulation through the medium of state commissions has been generally adopted throughout the country, most of the states in the Union now having commissions and controlling thereby the operation of all public service companies. In the main the activities of these commissions have led to better understanding of relations between the public and the utility company. A general disposition has been shown to use wisely the powers entrusted to commission bodies and in their administration to safeguard the equities of all concerned.

Special reference was made to the work of the rate research committee during the year and the influence the work and the recommendations of the committee will have for better standards in forms of contracts, applications, tariff schedules, rate principles, etc. Work of other committees, including that of the accident prevention committee, of the accounting committee, of the electrical salesman hand-book committee, and of the overhead line construction committee was mentioned.

President McCall, in conclusion, called attention to a needed change in the financial plan of the organization, inasmuch as the income derived from members of all classes is not sufficient to carry on important work. He recommended the investigation of a plan which will warrant most liberal treatment of Class B members, at the same time permitting them to possess an independent interest by contributing to the work of the association through the medium of a membership fee. He said there should be a re-rating of the dues in Class A and D membership.

The report of the committee on organization of the industry, presented by Vice-President H. H. Scott, of New York, showed the following membership on June 2, 1914: Class A, 1,091; Class B, 10,817; Class C, 73; Class D, 250; Class E, 785; making a total of 13,016. During the year there has been a gain among Class A members of 42 and among Class B of 561. The number of Class B members in company sections is somewhat less than a year ago, and the number of geographic sections has not increased.

The report of Secretary Martin, presented at this session, reviewed the growth of the monthly bulletin and the publication of other pamphlets and works of the association. It showed that 4,150 copies of the Meterman's Handbook have been sold, a new handbook on overhead line construction of 900 pages, and a new pocket size loose-leaf salesman handbook issued during the year. The rate research bulletin has reached its fifth volume, with 583 subscribers.

The report of the insurance expert, presented by W. H. Blood, Jr., of Boston, referred especially to the importance of two matters to come before the fire underwriters in New York City next March—namely, the revision of rules on constant potential pole lines of over 5,000 volts, and on the use of renewable and refillable fuses. The work of inspection bureaus and the examination of central station properties with a view of reducing liability of fires and insurance premiums was touched upon.

The report of the committee on progress by Secretary T. C. Martin was full of interesting data and information, making it, as usual, a masterpiece of its kind in summing up the technical, commercial and other features of progress in the central station industry. The advance in all fields was touched upon, such as lamps, lighting, electric vehicles, electric heating and cooking, railways, industrial usage of electricity, electric pumping and ice making, signs and slogans, and electricity on the farm, and miscellaneous applications of electrical energy.

The report on the question box by S. A. Sewell, the assistant secretary of the association, showed that during the year 254 new questions had been published, with 1,296 answers coming from 746 contributors.

The interesting paper of this session was delivered by Mr. Paul Lupke on "Safety First." This paper was up to Mr. Lupke's well-known standard, and will form an addition to the classic papers already presented by him at previous conventions. The author appeals to the rank and file for the development of the convention spirit, and points out various causes for the lack of this spirit. "The man who can keep his head level in an emergency and instantly recognize a true Carnegie medal occasion that demands taking a risk is a real hero. Nowhere else does dire tragedy tread so closely and so frequently upon the very heels of the supposedly harmless fun than in the working out of a practical joke," said he.

REPORT ON PUBLIC POLICY.

The second general and executive session was held Wednesday evening. At this time the report of the public policy committee was read by Mr. Samuel Insull, of Chicago, in the presence of a number of noted electrical men, including Thomas A. Edison, Charles F. Brush, Frank J. Sprague, E. W. Rice, Jr., Guy E. Tripp, Frederick Nichols and T. N. McCarter. After reading the report, Mr. Insull spoke of the interests of the central station industry as being bound up with the prosperity of the country at large. The amount of current used in any community depends upon the business conditions in that territory, and yet so rapid has been the growth of the industry that expansion takes place even in periods of depression. The older of the public service utilities, he said, whose business has more nearly approached the point of saturation, are much more sensitive to general business conditions. He called attention to the seriousness of any legislation which might be attempted by the national Congress with intent to limit the areas that might be served by the central station, yet he made it plain that the business is necessarily subject to regulation either by state, national or municipal bodies. It is naturally a monopoly and can be most economically operated when the greatest diversity of service is permitted. In England, by the act of 1884, the electric light and power business received such a check that, if it had occurred in the United States, we would now be meeting by tens and twenties insead of by thousands, said Mr Insull. "We must come before the people with a clean-cut reason for existence, frankly presenting the economics of our business, showing the natural advantages to the community of monopoly, and pleading for the fullest interchange of energy between geographic areas."

Following the report of the public policy committee, exercises in celebration of the thirtieth anniversary of the First International Conference and the First International Electrical Exposition at Philadelphia in 1884 were held. Mr. E. W. Rice, Jr., president of the General Electric Company, spoke on electrical conditions existing in the year of the Philadelphia exhibit as compared with present-day development. He said that not a trolley car was in existence, and that the highest potential employed was 2,000 volts, with the largest electric generator, the "Edison Jumbo," rated at 1,200 sixteen candle-power lamps. The

Fig. 1. One of the Aisles on the Exhibit Floor of the Bellevue-Stratford Hotel During N. E. L. A. Convention.

electric motor was just coming into use, less than 500 horsepower having been applied.

Mr. Charles F. Brush, famous for his arc lighting system, gave some interesting reminiscences of his experiments with electric lighting. He reviewed the early days of electric lighting, touching upon the essential points involved, and concluded by saying that at the present day the industry has grown so as to be capable of absorbing capital at the rate of one and one-half million dollars every working day.

Mr. Frank J. Sprague spoke on railways, past and future, referring to the installation of the electric street car line in Richmond, Va., in 1887. He referred to the feeling when electricity was substituted for steam on the New York elevated railways in 1890, and said that the centralization of generation with interconnected transmission lines following the railway right of way is now a certainty, and with it electrification of railways will follow. He also referred to electrical signal work and the necessity for automatic braking.

At the final session on Friday morning Mr. H. H. Scott reported the awards of the Doherty medal and the Harriet Billings cash prize, given for meritorious papers presented before company sections. The first was awarded to Harold Goodwin, Jr., of the Philadelphia Electric, and the second to H. B. Gear, of the Commonwealth Edison, of Chicago. The committee recommended further that these papers be published in the proceedings of the association.

Following the awards, Mr. Wakeman outlined the purposes of the Society for Electrical Development, and Mr. Martin gave the report of the committee on memorials.

In speaking on the constitutional amendments adopted, President McCall mentioned readjustments desirable for Class D members. He also stated that about 50 per cent of the revenue of the association was derived from the dues of employes. He gave it as his opinion that this was not right, but that the expense should fall largely on the member companies as those most directly benefited.

In offering the resolutions, Secretary Martin made special mention of the railroad and hotel facilities, especially the accommodations provided by the Bellevue Stratford, the courtesy of the daily and technical press. Mayor Blankenburg and other city officials, the president and other officers of the Philadelphia Electric Company; also of the work of Mr. W. C. Eglin, the convention committee and the exhibition committee.

Thanks were also extended to the Franklin Institute, and to Messrs. Thomas A. Edison, Frank J. Sprague, Chas. F. Brush and E. W. Rice for interest and participation, and the convention voted to send a telegram to Miss Harriet Billings in token of the good wishes of the association.

The nominating committee named the following as officers for the next year, and each was elected: President, H. H. Scott, Doherty Operating Co., New York; vice-presidents, E. W. Lloyd, Commonwealth Edison, Chicago, Ill.; H. A. Wagner, Consolidated Gas, Electric Light & Power Co., Baltimore, Md.; L. D. Gibbs, Edison Electric Illuminating Co., Boston; J. S. Bleeker, Columbus Power Co., Columbus, Ga.; treasurer, W. F. Wells, Edison Electric Illuminating Co., Brooklyn; secretary, T. Commerford Martin. Members of executive committee, Paul Spencer, Philadelphia; A. C. Einstein, St. Louis; Walter Neumiller, New York.

After a few remarks from the newly-elected president, the association adjourned to meet at San Francisco in June, 1915.

While President-elect Holton Henry Scott is not yet 40 years of age, having been born in September, 1874, he has been identified with and responsible for as much real association work as any member of more years. His work as chairman of the organization committee of the association during the past five years has brought his ability into prominence, and his election is just recognition of a very remarkable record—namely, an increase in number of members from 3,000 to 13,000. Besides acting in this capacity, he has been a member of the executive committee for three years and a vice-president for two years.

Mr. Scott was born in Canada, coming to the United States in 1882, and getting his education in the High School of Ashland, Wis., and the University of Wisconsin, where he graduated with the degree of B. S. Since his graduation in 1896 he has been in the employ of Henry L. Doherty at Madison, Wis., four years, then at Lincoln, Neb., two years, and at San Antonio, Tex., three years. In 1905 he returned to Madison, Wis., as general superintendent of the Madison Gas & Electric Company, and in 1905 went to New York as chief engineer for Henry L. Doherty & Co. to examine all properties owned and taken over by the company. His present position is general manager of the Doherty Operating Company, which has to do with 104 properties in all parts of the country.

Holton Henry Scott, President-Elect of National Electric Light Association.

Commercial Sessions.

The first commercial session was opened on Tuesday afternoon with an address by Chairman T. I. Jones, of Brooklyn, who briefly outlined the growth, present status and future purposes of the commercial section, which started in 1910 with 163 members and now has a total of 1,460. The additional dues required of commercial department members have retarded its growth, and it was proposed at this meeting to amend the constitution, which action was taken later at an executive session, so that each member pays only the dues for general membership, yet is entitled to membership in a geographical and also in either the accounting, technical or commercial national sections.

Reports of the finance committee by Mr. E. L. Callahan, of Chicago, and of the membership committee by J. F. Becker, of New York, were next presented.

The report of the committee on publications was presented by Douglass Burnett, of Baltimore. He spoke of the publications issued during the year on such topics as "store service," "church lighting," "ornamental street lighting," etc., of which 130,000 copies have been issued. As yet, however, only about 13 per cent of the member companies have availed themselves of the work of this committee. The latest production is in the shape of thirteen pieces of literature designed to form a follow-up series to be mailed to non-customers at stated intervals. There is a very large undeveloped residence business awaiting the central station. A census in a territory representing a population of eleven million showed 425,000 unwired houses. At this rate there would be over a million in the United States. These publications are furnished to member companies at simply the cost of printing.

During the discussion on this report, Mr. Learned, of Chicago, told of the benefits derived by his company from the circulation of a publication known as "Electricity in the Home." Mr. Donkin, of Pittsburg, said that his company has advertised that, on request, applicants would be furnished with a pamphlet describing the uses of electricity, and received numerous mail, phone and personal call requests for same that could be traced into new business from the resulting publicity and education.

Mr. Young, of Newark, spoke of the lack of machinery for the purpose of circularizing, stating that there should be a bureau in charge of this work.

Mr. Pullen, of St. Louis, criticised the advertising matter as being written too much from the central station point of view, and thought it should be aimed more at the housewife. There was also the criticism that the advantages of electric light were slighted in the preparation of this series. Appliances offer a good argument in some cases, but the business has been built up on the lighting load, and this should be emphasized.

Following this discussion, Mr. Chas. J. Russell described the new commercial handbook, which consists of 1,500 sheets, 4 by 7 inches, with a desk file in which the sheets may be kept in order. The sheets are printed in four colors, to designate data on power, lighting, heating, or electric vehicles. They are also numbered according to the decimal system, and classified according to trades and kinds of business. In discussion, Mr. Seelman, of Brooklyn, stated that the value of the handbook depended altogether on the use that was made of it. He urged managers to become familiar with it as well as recommend it to their salesmen. Mr. Macbeth explained some points in connection with the indexing.

The report of the committee on education was read by Fred R. Jenkins. It indicated a demand for educational work and outlined a course of study, consisting of salesmanship, power and lighting applications, merchandising, rates, wiring and general information. The committee had sent out requests for opinions to a large number of companies, and the majority of the replies showed interest, but a wide difference of opinion as to the best methods. Some favored correspondence schools; others a course prepared by the committee; others lectures with examinations, etc. The committee recommends that the most effective way of giving this instruction is by means of lectures by the heads of departments, on which the employes shall take notes and be required to take examinations. Occasional lectures by outside authorities should also serve to add interest.

It was suggested, during the discussion on the report,

FIG. 2. ANOTHER SET OF EXHIBIT BOOTHS AT THE PHILADELPHIA CONVENTION OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

that the handbook be used as a basis of instruction, supplemented by lectures. Another spoke of the change in the way of handling men. A few years ago solicitors were fed from a spoon, but now it is put up to the man that if he wants to keep his job he must know his business.

Mr. Lloyd, of Chicago, spoke of the work of the Chicago Central Station Training Institute, maintained jointly by four companies. This is a night school, and the men pay for their tuition. These men make the best salesmen in the industry. Mr. Hart, of the Northern Illinois Utilities Company, spoke of the necessity of having men who can work without supervision in their widely scattered territory. He has been using the men from this school and finds that they excel as business-getters. Mr. Brown, of the New York Edison, suggests written lectures, but oral examinations.

The report of the committee on rate research was read by E. W. Lloyd, of Chicago. It discussed in the main the factor in rate making known as the "value of service," which takes up a consideration of the rate at which the customer can serve himself or be served under free but not destructive competition. The committee stated that while the cost of service was often hard to estimate, the value of same was often a more satisfactory basis for rate making. A further point was made that after all the business that can be secured at a given rate is taken on, additional business might be taken at a lower rate without injustice to existing customers. There is a test of value according to use, as, for example, power rates as distinguished from lighting. There is also a difference of value according to time and place, such as summer and winter load, or current delivered at the power house as compared with that delivered at a distance. The trend of the discussion was to the effect that any attempt to get away from the cost of service as a basis for rates would be looked upon by the public service commission as a return to the old principle of "all the traffic will bear." In the end the value of service depends closely upon the cost of service plus a reasonable return, since free competition will reduce rates to this point, and destructive competition will force them below it. It is, therefore, between these two limits that the central station must make its rates.

Mr. H. L. Scherck, of Poughkeepsie, N. Y., urged that the committee get data on rates and costs of street lighting service and present them in its next report. In summing up Mr. Lloyd stated that the value of service had been recognized by the Massachusetts commission, and that other bodies have incorporated the same principle in their decisions.

The report of the lamp committee was presented by F. W. Smith, chairman. As usual, this report discussed fully statistics of lamp sales in 1913. Over 100,000,000 lamps were marketed last year, an increase of 59 per cent over 1907. Many changes in the proportion of different kinds are apparent. The tantalum lamp has decreased to less than 1/10 per cent of the total. The Gem lamp also decreased slightly in percentage last year, while the tungsten lamp sales are going upward by leaps and bounds, being now over half of the total. The sales of tungsten lamps were also analyzed as to size. The 25 watt size leads with 29 per cent, while the 25 to 60 watt sizes, inclusive, cover 72 per cent of the tungsten lamp sales. Supplementing this report, some interesting questions and answers typical of practice in the matter of lamp renewals were given.

Following this report, Preston S. Millar, of the Electrical Testing Laboratories, New York City, gave a demonstration of a number of lighting units. He exhibited a collection owned by the Franklin Institute containing types of lamps manufactured from 1880 to the present. These included the bamboo filament, the carbon and metallized carbon, the tungsten, and the non-vacuum metal filament types. He further exhibited the smallest and the largest of the 110 volt tungsten lamps, from 10 to 500 watts; the non-vacuum or "type C Mazda," from 400 to 1,000 watts; also the largest and the smallest metallic filament lamps made, varying from the 1/10 watt, or "grain of wheat" lamp, to an experimental lamp of 2,500 watts. He also showed some of the "type C" lamps that had been burned a number of hours to show that the blackening with age took place in the neck of the lamp, instead of all over the interior surface, as is the case with the exhausted lamp. Other lamps were also shown in which the bulb had been ruled with fine lines, thus apparently drawing out the filament by refraction.

Turning to larger lighting units, the D. C. carbon arc, the D. C. 10 amp. flamer, at .5 w. p. c.; the gas filled Mazda, in a lighting fixture at .75 w. p. c.; the quartz lamp, at .6 w. p. c., and the magnetite lamp, at 1.0 w. p. c., were shown in operation. Improvements in the magnetite lamp are promised which will bring the consumption down to .7 w. p. c. Mr. Millar then exhibited an experimental form of Titanium carbide lamp which operates at .4 w. p. c., but which, as commercially used, will likely run about .65 w. p. c. Finally the speaker exhibited an experimental lamp consuming 25 amp. at 110 volts.

In discussing the report, Mr. Howell, of Harrison, N. J., explained the effect of gas introduced into a lamp bulb. It lowers the temperature, affects the evaporation of the filament, and changes the location of the discoloration. The cooling effect varies with the gas, the shape and thickness of filament. Other gases are now being tried. There is practically no upper limit to the sizes in which these lamps can be made. S. E. Doane, of Cleveland, spoke of the high degree of perfection and standardization to which the incandescent lamp has been brought as a result of cooperation of the N. E. L. A. Norman Macbeth called attention to the increase in average candle power as shown in the report. This is a matter of education. Much can be done to encourage the use of the larger units by a proper scaling of the prices.

At the third commercial session held Thursday morning, the report of the committee on interurban lighting of highways was read by Mr. Geo. B. Tripp, of Harrisburg. This committee found a great lack of information on this subject and a desire on the part of central station managers for information. The committee has made investigations in the neighborhood of Boston and Lynn, Mass., as to units suitable for this work. They recommend the use of a 100 watt tungsten lamp as a small unit, and high candle power tungsten units and magnetite arcs with refractors where larger units are desired. The discussion brought out varied opinions, but little in the way of information. Mr. Kelly, of Dayton, reported a few stretches of roadway from 1 to 3 miles long lighted with 75 watt lamps every 300 feet. Mr. W. D. A. Ryan, of Schenectady, spoke of a plan for lighting a highway from New York to Buffalo. Mr. Ryan also described the proposed lighting for the Panama Pacific Exposition, which he has designed and will represent new applications.

Following this report the delegates and guests were treated to an address from Elbert Hubbard, or Fra Elbertus, as he is colloquially known. His topic was "The Age of Co-Operation." In his opening remarks he referred to Maeterlinck's "Life of a Bee," and recommended it as a study. "A bee alone," said Mr. Hubbard, "has no intelligence, a bee alone makes no honey, for a bee alone is helpless. A hive of bees has a great intelligence; they are very close to some of the mysteries of nature; and they have solved problems that have baffled mankind. A man alone likewise has no intelligence, and the more points of contact he can have with humanity, the better and wiser he will be. The badge of sanity is the ability to co-operate, to do team work. No man is so wholly right that he can say to the other fellow, you are wholly wrong. Getting together is a matter of mere psychology." Mr. Hubbard said that success in business is due to a combination of work, play, study and laughter mixed wih love. "The business world," said he, "is adopting the motto 'Truth,' and men are learning that dollars are but the counters in the game of life. Any man who makes two grins grow where only a grouch grew before will get paid for his effort. We are all down on a payroll at a certain equal basis per day and if we are not getting the full amount of this basis it is because we are costing our employer something for supervision. We have passed through the ages of feudalism and competition and now entering the age of co-operation."

The report of the committee on non-peak and high load factor busines,s was presented by Geo. H. Jones, of Chicago. Interest and depreciation is a greater factor in the cost of electric service than the price of coal, and hence load factor becomes of great importance to the central station. High load factor was defined as that of 30 per cent and upwards, while non-peak business was defined as that which can be taken on without additional plant investment. Various lines of business were discussed and data given on operation. Vehicle battery charging which is done during the small hours of the morning is perhaps the most profitable of any load that can be secured. The small business in this line has not been reached. It is believed that by making a fixed charge per month plus a small mileage charge that a larger amount of this business can be secured. Figures on ice-making were given. In Chicago there are five ice plants now being constructed which will make a total of 15 using central station current. The consumption is half a ton per year per inhabitant. During last year 166,000 tons of ice were made in Chicago. It was the opinion of the committee that office buildings could be taken on during the summer when steam was not needed for heating, with advantage both to the central station and the owners of the buildings.

There was a good deal of discussion in regard to this point. Mr. Stephenson of Brooklyn and others seemed to feel that to take on the load of an office building during the summer was an admission that isolated plant operation was cheaper during the winter, and that even present customers for all-year operation might be influenced to start up their plants again during the winter. Others, however, seemed to think that the summer operation by central station service might prove so attractive that it would afford a strong argument for all-year service. At any rate, if there is business that the central station cannot profitably take, it may as well be admitted. Further discussion turned on the hours of labor, and whether manufacturers can afford to alter the hours of work so that the power load would not overlap the lighting peak for the sake of getting off-peak power rates. One company mentioned found it profitable to shut down an hour earlier in winter to gain the lower rates offered.

The first part of the report on wiring existing buildings was presented by the chairman of the committee, R. S. Hale, of Boston, who spoke of the large amount of business to be obtained along this line. The main aids to getting this business are to solicit it vigorously, enlist the co-operation of contractors, and to have, if possible, a simple schedule of costs on the basis of outlets, so that a solicitor can close up a wiring agreement without delay.

The second part of this report dealt with inexpensive wiring methods in Europe, and was read by S. E. Doane. European companies have gone a great deal further in the matter of getting small customers than we have in this country. The wiring is run exposed in neat two-wire, flexible, metal-covered conductors at a considerably less cost than is possible here, using approved material. The current is sold mostly on the controlled flat rate system, using what are known as "current limiters." The proposition is financed by the central stations, the user paying a rental for the wiring slightly above the interest on the investment cost. By means of these methods, the European companies have secured thousands of very small residence customers, whose aggregate consumption is considerable.

In discussion, the remark was made that the Underwriters, by requiring expensive construction, are rendering the cost of electric light prohibitive to many persons who could otherwise be obtained as customers. Speaking for the Underwriters, Mr. J. E. Latta, of Chicago, assured the section that the Underwriters desire to encourage the use of electric service. He stated that the N. E. L. A. or any other electrical organization having an interest in the matter are at liberty to attend the meetings of the committee that formulates the National Code and to express their opinions. Mr. Donkin, of Pittsburg, stated his experience with the excess indicator over a period of three years. His company has 48,000 customers, of which 3,000 are on controlled flat rate. This business yields a revenue of $60,000 per year. There are about 48,000 unwired houses in the territory. One contractor wired from 800 to 850 houses at a cost of less than $10,000. The reports of others having had experience with the excess indicator would indicate that from 25 to 30 per cent of the flat rate customers soon desire a change to meters.

Following this discussion, there was a report and discussion on the question of standard plugs and receptacles. The committee had not been able to persuade manufacturers to get together, due to patent situations. In the discussion it was brought out that the Underwriters were reluctant in allowing receptacles to go on lighting circuits, with the result that the customer attaches heating devices to the lamp sockets, thus introducing a liability of more trouble than if receptacles were used. In order to encourage the use of appliances, small receptacles should be allowed to go freely on lighting circuits. Mr. Young, of Camden, recommended the wiring of the kitchen and dining room on a separate circuit, using No. 10 wire.

A report on electrical merchandising and advertising was presented by P. H. Kemble, of Cincinnati and was divided into three parts. In the first part suggestions were given on organization and management of appliance departments, plans of show rooms, records, etc. The committee favored selling appliances at a fair profit and enlisting the co-operation of dealers and contractors. In the next section examples are given of successful copy used in appliance campaigns, together with a general synopsis of advertising principles. In the third part suggestions for the training and handling of the sales force, and a list of books and other literature dealing with the subject of advertising, were presented.

In the discussion some good points were briefly brought out. Mr. Learned, of Chicago, said that with 18 show rooms, covering a territory populated by 50,000 people, that nearly 8,000 appliances had been sold during the year. Mr. Dodd, of New York, spoke of the advantage of arousing the general public interest in the uses of electricity. He urged members to join the Society for Electrical Development and aid in its work.

Technical Sessions.

The first technical session was opened Tuesday afternoon at 2:30, with W. F. Wells, of Brooklyn, presiding. The report of the committee on meters was abstracted by Chairman P. H. Bartlett, of Philadelphia, which report covers 149 pages and takes up progress in design of meters during the past year, as well as some public utility regulations and laws covering meters. The committee mentioned the increasing interest throughout the industry in demand meters of all types. A classification of maximum demand services was also presented, as well as recent improvements in meters of the Sangamo, Esterline, Westinghouse, General Electric and other meter designs. The discussion on this point brought out the importance of securing a cheap, reliable type of demand meter.

FIG. 3. AN ARCH ERECTED NEAR THE ENTRANCE OF THE BELLEVUE-STRATFORD HOTEL DURING N. E. L. A. CONVENTION.

The report on grounding secondaries was presented by W. H. Blood, Jr., of Boston, and showed that out of 575 companies responding to inquiries, only 325 have grounded secondaries. It has been learned that the larger companies use grounded secondaries, and the committee urged that smaller companies follow suit and avoid the risk involved in not following the practice. The character of grounds to be used was touched upon and grounding to water pipes recommended wherever possible.

During the discussion of the report, Dr. Steinmetz said that failure to ground secondaries is liable to be held as criminal negligence in case of an accident resulting from an omission of this practice by central stations. Engineers universally agree to the efficiency and merit of the water-pipe ground.

The report of the committee on electric measurement was presented by Dr. E. E. F. Creighton, of Schenectady, in the absence of Dr. A. E. Kennelly. This report took up the history leading to the adoption of an international standard of electrical conductivity of copper by the International Electrotechnical Commission of Berlin, Germany, in September, 1913.

This report was followed by an address on the electrical vehicle by Dr. C. P. Steinmetz. Dr. Steinmetz talked to a large audience and discussed the past, present and future of the automobile, contrasting the development of bicycling as a sport with the use of the motor vehicle as such. He predicted that in the same way the bicycle has become a business proposition, so in the future will the automobile become largely a device used in a business way. He said that when this time is reached, high speed and long mileage characteristics in connection with motor vehicles will be no longer of importance on account of the fact that high speed and long mileage within a restricted territory effect no saving. He said that the average physician rarely covered more than ten to twenty miles per day, and that, on account of these facts, the electrical vehicle possessed characteristics that tend to make it superior to the gasoline car for such usage. He took up the possibilities for the central station in the promotion of the electric vehicle, advising that the station take care of cars of this kind rather than leave such work to a private garage. He estimated that the average recharge at 50 per cent of capacity of batteries for 1,000,000 cars throughout the country would represent a load of 1,500,000,000 kilowatt hours per year and an income at a 5 cent rate of $75,000,000. The demand for electric truck service, he stated, should equal that of the smaller business and pleasure cars.

In regard to practical features in connection with caring for electrical vehicles, Dr. Steinmetz believes that at a rate of $10.00 per month it would be possible for the central station to garage and care for electrical vehicles of the lighter type and enter into strong competition with the horse and gasoline car.

The second technical session was held Wednesday morning at 10 o'clock, and opened with a report of the committee on electrical apparatus, read by Chairman L. L. Elden, of Boston, Mass. This report contained 82 pages, and reviewed the progress in the design of electrical equipment for power plant, substation and distribution service. It took up such matters as temperature measuring devices, large capacity rectifiers, the application of electrolytic arresters through synchronous converters, the nomenclature and transformer connections, preliminary work on switchboard manual, and a sub-committee report on the proposed revision of A. I. E. E. standardization rules.

A paper was next read on temperature and its effects on power capacity by F. D. Newbury, East Pittsburg, Pa. The paper had to do with internal temperature conditions in large alternators, and gave test data under service conditions, with deductions as to safe temperatures for various classes of installation.

The report of the committee on underground construction was next presented by L. L. Elden. This report covered in a general way underground distribution, and included sub-committee reports on alternating current systems, underground transformers, high tension cable joints, cable protection and manholes, low cost underground distribution systems, data on high tension cables, burn-outs, etc. A discussion on this paper included experiences of companies in installing underground systems and the difficulty in securing suitable ventilation in manholes containing 300 Kw. and upwards in transformers.

The report of the overhead line construction committee was read in brief by Thomas Sproule, of Philadelphia. The material presented was a revision of a portion of the 1911 report covering primary and secondary line construction. The report is a part of an 800-page handbook on overhead line construction, prepared by a sub-committee. The handbook contains much data on methods and material, and considerable space is devoted to the general subjects of wooden pole line construction. Steel tower construction has not as yet been featured. The work of the committee was complimented and a resolution introduced extending the thanks of the association to the committee for its painstaking efforts. On account of later recommendations of the committee, it was also moved to rescind the qualified approval of the 1911 report, and that the question of voltage limitation be eliminated from any recommendations or reports of any committee of the association. A resolution embodying these points was carried by a large majority.

Hydro-Electric Sessions.

The first hydro-electric and transmission session was opened by the address of the chairman, W. W. Freeman. Mr. Freeman referred to the report of Secretary Martin on the progress of the hydro-electric and transmission section, stating that this report covered the essential details. He said that after careful consideration the executive committee had decided that there was no advantage in continuing the hydro-electric and transmission section as a distinct organization on acount of the limited possibilities, believing members can secure larger benefits if the work proposed for the section be handled by special committees, similar to the public policy committee. This suggestion of the executive committee was accepted.

Secretary Martin next presented an abstract of the report of the committee on progress, in which reference was made to developments that have taken place recently in making transmission possible over long distances. Data on recently completed hydro-electric installations and transmission systems in this country and abroad, and the essential features in transmission line practice, design, etc., were touched upon in the report. Three of the papers scheduled for this session were then read and discussed jointly. These papers were as follows: The Nature of Electrical Disturbances in Transmission Work, by G. D. Rushmore, of Schenectady; Data on Modern High Voltage Tranmission Systems, by Selby Haar, of New York City; and Water Power Plant Economics, by O. B. Caldwell, of Portland, Ore.

The first paper took up disturbances caused by high currents and those caused by high voltages. It was pointed out that the destructive effects of high current may be reduced by increasing the reactance in the circuit, by providing external power limiting reactances, and by sectionalizing through selective switch devices. The use of synchronous condensers and automatic voltage regulators was mentioned for regulation of modern transmission systems of high voltage. The use of the aluminum cell, lightning arresters as a protection against high voltage disturbances where excessive voltage occurs between the phase conductors or between the phase conductors and ground, was also mentioned. Protection against disturbances due to high frequency is being studied, and the committee advised the insulation of both end turns of winding and individual group coils.

The second paper mentioned was a collection of data on transmission lines operating at voltages of 70,000 and higher. At present 31 systems are in operation at 100,000 volts or higher and 56 at 70,000 volts or higher. The paper on power plant economy, by O. B. Caldwell, presented considerable information in the form of curves on investment charges and operating costs for steam and hydro-electric plants. It also discussed the different types of steam and hydro-electric plants and the merits of each. The discussion brought out the fact that it is usually more expensive to develop storage capacity than to install an auxiliary steam power plant.

The session was closed by a lecture on hydro-electric development in California by H. J. Lisberger, of San Francisco. The speaker took up conditions in connection with some of the large hydro-electric systems in the West, and described some of the conditions which make possible large generating capacity on the Pacific coast. Views of Panama-Pacific Exposition buildings were also shown.

The second hydro-electric session was held jointly with the third technical session Thursday afternoon. At this time the report of the committee on prime movers was presented in abstract by J. B. Klumpp, of Philadelphia, and J. F. Vaughn, of Boston. Aside from matters of standard practice in steam and water power stations, the report dealt with the experiments made at St. Louis, using oil under boilers. It also discussed a cinder-catching device used by the New York Edison Company, which causes flue gases to impinge against a wet baffle plate. The use of the steam flow meter was mentioned and the statement made that the best results can be obtained when the steam flow meter is supplemented with a good feed water regulator. Foreign practice and tendencies were taken up.

The Selection of Hydro-Electric Turbines, by Charles V. Seastone, of Madison, Wis., was next read by W. N. Ryerson. The author of the paper made the statement that, on account of lack of proper data on different types of water wheels, turbine equipments have been installed not always suited to operating conditions. The report explained the essential characteristics of turbines and the features required for particular service.

The report of the committee on street lighting was next presented by J. W. Lieb, of New York City. This report reviewed work done by the committee since its appointment in 1898. The committee has made arrangements for the installation of a variety of street lighting equipment, and a study is to be made of a varied nature. The subject is to be approached from a psychological standpoint and an endeavor made to observe in this way adequate illumination.

The report of the committee on accident prevention, by M. J. Insull, of Chicago, was next presented, and gave instructions to members of the association on safety first problems. Blanks for reporting accidents and methods of tabulating causes and results were discussed. A motion picture film was displayed contrasting careful and careless methods in line work, suggesting the use of insulating shields or covers when possible. The safety movement was strongly recommended by the committee.

Accounting Sessions.

The first accounting session was held Tuesday afternoon, and opened with an address by the chairman, H. M. Edwards. Mr. Edwards outlined the work of the year, and said that the time has come for the accounting committee to determine upon an organization that will be more representative of the industry. At the present the president of the association selects the committee, and Mr. Edwards suggested that the delegates attending the convention be permitted to select their own officials. He said that the most important work of the accounting committee was the completion and formal adoption of the classification of accounts. He also suggested that special assessment of members of the accounting committee should be discontinued, and only the regular N. E. L. A. membership be required. A motion was made to this effect and passed. It was also moved and adopted that the committee be organized along national lines.

The report of the library committee, presented by C. L. Campbell, stated that 7,380 forms had been received from 127 different companies and filed according to size of city and according to topics of forms.

The report on costs and statistics, by Thomas J. Walsh, took up methods used by the Commonwealth Edison Company in studying expenses. This company has adopted the classification of accounts recommended by the N. E. L. A. and subdivided the accounts to meet its requirements.

The second accounting session was held Wednesday morning, and opened with the report of the committee on uniform system of accounts. The report outlined the tendency in the classification of accounts, the classification being a revision of one presented at last year's convention. The classification is divided into construction, current asset, liability, reserve, income, operating and maintenance, commercial expense, new business, general expense, deduction from income and appropriation accounts. Discussion on this report brought up various practices in regard to handling accounts of the different companies. The discussion was one which interested all, and on which a large number had something to say. The report on uniform systems of accounts was followed by a paper on appraisals of electric light and power plants by Dr. Jackson, of Boston.

The third and last accounting session was held Thursday morning, and a paper on variations in public service systems of accounting, held over from the previous session, was presented by E. C. Scovell, of Rochester. The author of this paper compared classified accounts from several states showing the differences. As an appendix to the paper, a tabulated list of the accounts investigated was presented.

The next paper was entitled "Accounting for Merchandise Sales," by H. Z. Lomayer, of Baltimore, Md., followed by a paper on Suspense Accounts, by Frederick Schmidt. The first paper took up methods used by the Baltimore Consolidated Company and outlined the routine for handling accounts on the company's books. The sale system is a duplicate-ticket plan, similar to that in vogue in large department stores. The second paper took up suspense in two groups—first, those accounts of a doubtful nature, and those accounts commonly known as clearance or apportionment accounts. A description of all accounts was given and special reference made to keeping storeroom expense accounts, as well as other matters of a kindred nature.

A paper on Mechanical Sorting and Tabulating Systems, by F. A. Birch, of Philadelphia, was next presented, and took up a system of accounting for purchases and distribution of charges to classification expense accounts. The use of tabulating machines was touched upon. The machines afford a very valuable check on mathematical accuracy of the month's work and make posting to ledgers rapid. Mr. Birch referred especially to distribution accounts and described the system used in accounting for purchases by the Philadelphia Electric Company. This paper was followed by one on sorting and tabulating machines, with special reference to use on the distribution system work of the Edison Electric Illuminating Company, of Brooklyn. A code system of numbering is used to classify material and equipment used in transmission and distribution. The paper pointed out that the use of code numbers simplifies inventory taking, since the code is designed to indicate only such characteristics of the material as are required to estimate its unit value in reports of physical property.

The last paper of the session was entitled "Purchasing, Storing and Accounting of Coal for the New York Edison," by Charles R. I. Lehman. The paper was illustrated with lantern slides which showed the system of coal storage and lighting which permits the carrying on of such work at night. Transportation and cost records were explained and copies of forms shown. Coal is purchased by a yearly contract, and all coal not required for immediate use is stored in a yard of 150,000 ton capacity. Extensions are now being made to accommodate 300,000 ton capacity, and facilities are being provided to increase the unloading and reloading rate of 1,800 tons and 20,000 tons, respectively.

Entertainment Features.

The entertainment features of the convention were thoroughly enjoyed by all. A large number visited Willow Grove Park on Tuesday evening, where a rejuvenation of the Sons of Jove was held. Later there was a special band concert and an exhibition of an electric fountain. In this fountain there were many separate jets of water rising to various heights and at different angles, each jet being independently illuminated by powerful rays of light of any desired color. The beam of light is directed not at the outside, but *inside* of the jet, the internal reflection causing the illumination to follow the path of the jet until it is broken into spray, producing the effect of luminous and brilliantly colored liquids, each jet maintaining its own color throughout its course.

On Friday afternoon about 200 of the delegates, among whom were many ladies, were entertained by a trip to the hydro-electric development at McCall's Ferry, on the Susquehanna River. The trip was made possible by Mr. Herbert A. Wagner, vice-president of the Consolidated Gas, Electric Light & Power Company, of Baltimore. The party was divided into groups of ten, and each group was conducted through the plant. At this point on the river there is a bend, and this fact is utilized to keep the ice out of the intakes, the ice being carried by its own inertia past the gates and over a spillway designed to take care of it. Seven units of 16,500 horsepower are in use. Excavation is being carried on for the eighth, and there will ultimately be ten units. One line of No. 1 copper leads toward Lancaster, and another line of 300,000 c. m. aluminum conducts the greater bulk of the power to Baltimore. The dam is nearly half a mile long and 60 feet in height. The Baltimore line crosses the river with a span of 1,750 feet.

Exhibits at Philadelphia Convention.

American District Steam Company, North Tonawanda, N. Y.—Model of underground steam heating fittings.

American Ironing Machine Company, Chicago, Ill. — Ironing machines.

Barnes & Kobert Manufacturing Company, New Haven, Conn.—Pressed steel pole line specialties.

Bell Electric Motor Company, Garwood, N. J.—Motors.

James G. Biddle, Philadelphia, Pa.—Measuring instruments.

Carbolineum Wood Preserving Company, Milwaukee, Wis. — Wood preservatives.

Central Station, New York, N. Y.—Periodicals and books.

Century Electric Company, St. Louis, Mo.—Motors and fans.

Copeman Electric Stove Company, Flint, Mich.—Electric stove and heating appliances.

George Cutter Company, South Bend, Ind.—Street-lighting fixtures and ornamental posts.

Delta-Star Electric Company, Chicago, Ill.—High-tension equipment.

Harvey Deschere & Company, Hoboken, N. J.—Electric signs.

Edison Lamp Works of General Electric Company, Schnectady, N. Y.—Reflectors, tungsten lamps.

Edison Storage Battery Company, Orange, N. J.—Edison battery.

Electrical Review Publishing Company, Chicago, Ill.—Periodical.

Electric Service Supplies Company, Philadelphia, Pa.—Lightning arresters and insulators.

Electric Storage Battery Company, Philadelphia, Pa.—Storage battery plates.

Electrical World, New York, N. Y.—Periodicals.

Federal Sign System (Electrical), Chicago, Ill.—Electric signs and household electric appliances.

G. & W. Electric Specialty Company, Chicago, Ill.—Cable end bells, junction boxes, distribution boxes.

General Electric Company, Schnectady, N. Y.—Reception booth.

General Vehicle Company, Inc., Long Island City, N. Y.—Reception booth.

Hubbard & Company, Pittsburgh, Pa.—Pole-line hardware.

Hughes Electric Heating Co., Chicago, Ill.—Electric ranges.

Hurley Machine Company, Chicago, Ill.—Electrical devices.

H. W. Johns—Manville Company, New York, N. Y.—Line equipment and supplies.

Lombard Governor Company, Ashland, Mass.—Valves.

W. N. Matthews & Brother, St. Louis, Mo.—Electrical specialties.

Metropolitan Engineering Company, New York, N. Y.—Protected service and meter testing devices.

National Lamp Works of General Electric Company, Cleveland, Ohio.—Graphical representation of losses in revenue from low-lamp voltage.

Naugle Pole & Tie Company, Chicago, Ill.—Pole equipment.

Ohio Brass Company, Mansfield, Ohio.—Pin type and suspension type insulators.

Otis Elevator Company, New York, N. Y.—Models.

Philadelphia Electric Company's Supply Department, Philadelphia, Pa.—Central station, high tension specialties.

Philadelphia Electrical & Manufacturing Company, Philadelphia, Pa.—Arc lamps.

Philadelphia Storage Battery Company, Philadelphia, Pa.—Vehicle lighting, sparking and starting batteries.

Pittsburgh Transformer Company, Pittsburgh, Pa.—Standard distributing transformers.

John A. Roebling's Sons Company, Trenton, N. J.—Sample boards of all kinds of insulated and bare wires and cables.

Rumsey Electric Company, Philadelphia, Pa.—Meters.

Sangamo Electric Company, Springfield, Ill.—Vehicle, service and switchboard instruments.

Simplex Electric Heating Company, Cambridge, Mass.—Electric heating devices.

Southern Exchange Company, New York, N. Y.—Poles and cross-arms.

Standard Underground Cable Company, Pittsburgh, Pa.—Reception booth.

Wagner Electric Manufacturing Company, St. Louis, Mo.—Reception booth.

Western Electric Company, New York and Chicago.—Household electric devices.

Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa.—Indicating and switchboard instruments.

Westinghouse Lamp Company, Pittsburgh, Po.—Nitrogen filled and tungsten lamps.

Westinghouse Machine Company, Pittsburgh, Pa. — Reception booth.

Weston Electric Instrument Company, Newark, N. J.—Switchboard and portable indicating instruments.

Selection, Care and Operation of Carbon Brushes

BY E. H. MARTINDALE, E. E., MEMBER A. I. E. E.

Section 3. Commutator Slotting for Railway and Industrial Motors.

THE practice of slotting, often called grooving, or undercutting commutators, consists in cutting away the mica insulation between the commutator segments slightly below the surface of the commutator. This practice first came into general use in the railway motor field about 1907. By 1909, according to information compiled by the American Electric Railway Association, about 75 per cent of the electric railway companies in this country were slotting commutators. Some had just begun, while others had all of their commutators slotted. The practice has grown steadily until at this time propably from 90 per cent to 95 per cent of the railway motors are slotted. Practically all railway motors built at present, unless specifically ordered otherwise, are sent out by the manufacturers with the mica undercut. At first it was considered necessary to slot only those railway motors which continually developed flat spots, high mica, or were subject to flash-overs. The advantages of slotting were so quickly apparent, however, that the practice rapidly extended to all types.

Owing to the comparatively inaccessible location of railway motors and the difficulty and expense of changing armatures, it was necessary to use with unslotted commutators a brush with sufficient abrasive qualities to keep the mica always ground down flush with the segments. This naturally resulted in excessive commutator wear and frequent renewal of commutators. The Washington Railway & Electric Company, Washington, D. C., began the practice of slotting commutators in 1908 and completed it in 1909. In 1908 they put on 369 new commutators, in 1909 165, and in 1910 only 3, and these were on an old type of motor which they were selling to some small road, and the commutators were put on solely for the purpose of putting the motors in first-class condition. Before slotting, this road used 30,000 brushes annually, and after slotting it used only 3,000 brushes annually at a cost of three times as much per brush, or a total brush cost of less than one-third the former cost.

The practice is gaining headway now in the industrial field nearly as rapidly as it did a few years ago in the railway field, and on this account it will be interesting to consider the various methods used and to point out the important points which should, and, indeed, must, be carefully watched in order to obtain satisfactory results. As a general proposition, it may be stated that all motors and generators will operate better with slotted than with unslotted commutators. There are a few exceptions to this—probably less than 2 per cent—and the exceptions are due to such a high voltage between bars that short circuits are liable to occur or the operation of a machine in such a dirty, greasy atmosphere that the slots cannot be kept clean. In the largest steel plants in the Pittsburg district it is almost impossible to find a motor today which does not have a slotted commutator.

A company operating 50 or more direct current machines of 25 horsepower and above can well afford to buy one of the standard slotting outfits on the market, as the cost per machine will not be very high. For companies with less than 50 machines one of the many home-made devices may be more economical. For the cutting tool a circular saw or miller, ¾ inch to 1¼ inches in diameter, seems to give the best results. The saw may be mounted on the tool carriage of a lathe, as shown in Fig. 1, and may be driven by a belt from a line shaft or by a small motor mounted on the carriage. The saw should be driven from 700 to 1,400 revolutions per minute, and should be about .005 inch thicker than the mica to remove the mica completely. The slot should be 1/32 to 1/16 inch deep, as a shallow slot can be kept clean easier than a deep slot. If the commutators are of large diameter, one or two spacers of the same thickness as the bars may be used between saws and two or three slots cut at one operation.

Instead of a circular saw, a lathe tool ground to fit the slots may be mounted in the tool post and moved back and forth across the commutator by operating the tool carriage, or it may be mounted on a special stationary post and guide and moved back and forth by a hand lever. If the latter method is used, some lateral adjustment should be provided for the guide, as commutator bars are not always exactly parallel to the shaft.

Both of the above methods necessitate placing the armature in a lathe which is not always available, and several types of machines avoiding this are in use. In the hand tools shown in Figs. 2 and 3 the saw is mounted between two handles with adjustable shoes on each side to regulate the depth of the slot. With these machines the saw may be driven by a compressed air drill or by a small stationary motor through a flexible shaft. With these hand tools a clamp may be necessary to prevent small armatures from turning during the operation of the saw. Figs. 4 and 5 illustrate two types of motor-driven machines in which the slotting tool is moved backward and forward by hand. With

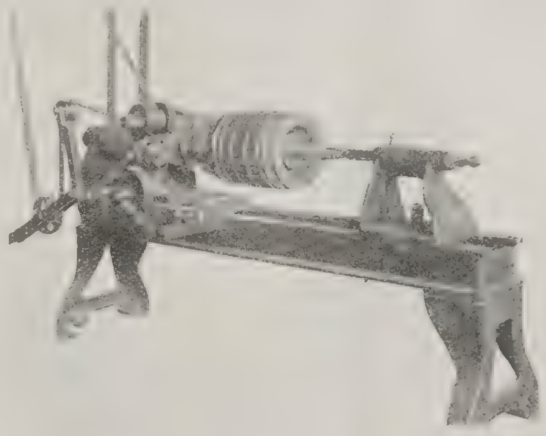


Fig. 1. Armature Slotting Apparatus Using a Revolving Saw and Lathe.

all of the machines using a high-speed saw, it is advisable to have a jet of compressed air or a fan so placed that the particles of mica and copper will be blown away from the operator.

A shaper equipped with a special tool, as shown in Fig. 6, will do rapid and satisfactory work. Where none of the above machines are available, or where the commutator is in an inaccessible position and is too heavy to be removed, satisfactory slotting can be done by broken pieces of hacksaw blades about 2 inches long clamped between two pieces of wood. The commutator of a 3,750 Kw., 275 volt generator in a station of the Cleveland Electric Illuminating Co., was recently slotted by this method. There were about 650 commutator bars, each 30 inches long, making a total of 1,625 feet, or more than a quarter of a mile of mica, yet it required four men only 20 hours to undercut the mica. A 25 horsepower machine may be slotted this way by one man in from 1½ to 3 hours.

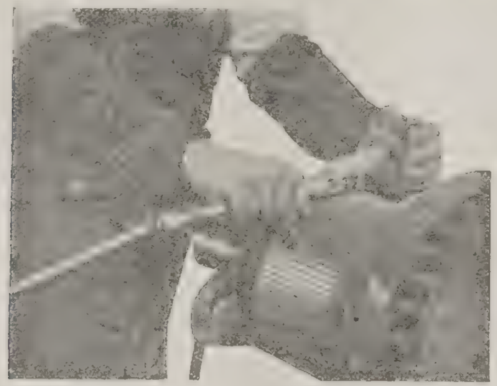


FIG 2. MOTOR-DRIVEN SAW OPERATED BY HAND FOR ARMATURE SLOTTING.

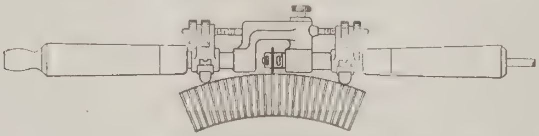


FIG. 3. THE HAND TOOL FOR ARMATURE SLOTTING, SHOWN IN FIG. 2.

The importance of getting the slots free from thin strips of mica along the edges of the slot is so great that it is advisible to take plenty of time to go over each slot carefully after slotting and remove with a sharp knife or thin tool any particles of mica flush with the segments. A very satisfactory method consists of going over each slot with a V-shaped tool, which bevels the corners of each bar, thus insuring a perfectly clean slot. Too much care cannot be exercised on this point, for nearly all the failures experienced with slotting are traceable to this cause.

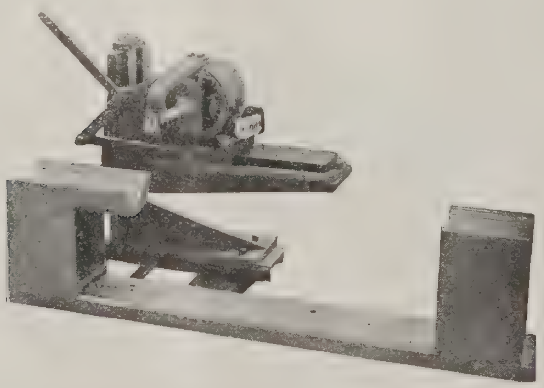


FIG. 4. MOTOR-DRIVEN SLOTTING MACHINES MOVED BACKWARD AND FORWARD BY HAND.

One of the largest electric roads in the middle West considers clean slots such an important factor that every commutator, after being finished, is gone over by an inspector with a large magnifying glass and every slot is looked at. If he finds any mica flush with the bars, it must be removed before the work is passed. If the commutator is not true, it should be turned before it is slotted, as otherwise the copper will drag over the edges of the slot and it will require considerable time to remove these burrs. After the slotting is completed the commutator should be carefully stoned with fine sandstone to remove any burrs of copper resulting from the slotting.

FIG. 5. VIEW SHOWING SIMPLICITY OF HAND SLOTTING ARRANGEMENT.

On all commutators which are undercut the slots should be cleaned at regular intervals, the frequency depending upon the amount and character of the dirt which collects in them. If the dirt is dry and light, it can easily be blown out with compressed air, but if oil is present the deposit may be gummy and the slots should then be scraped occasionally. Lubricant should never be necessary on slotted commutators. The removal of the mica permits the use of brushes without any abrasive qualities, and has resulted in the development of very low friction brushes. A brush need not be soft or graphitic to have a low friction. In fact, some of the very lowest friction brushes manufactured are hard and contain no graphite whatever. Such brushes will give to a slotted commutator that brown gloss which shows perfect operation, and the life of a hard, non-abrasive brush will be several times that of a soft graphite brush.

Slotting has been condemned by many men, because after undercutting the mica they did not obtain a brush suitable for use on a slotted commutator. Instead, they put back the same brushes they had used before, with the result that the commutator was ridged and worn rapidly, the slots

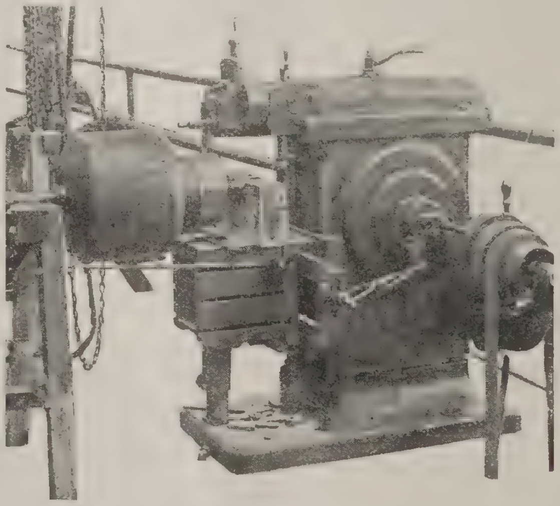


FIG. 6. SHOWING SHAPER EQUIPPED WITH SPECIAL SLOTTING TOOL.

were filled with copper dust, and short circuits and burned-out coils the result. The brush tension on a slotted commutator can often be much lower than on the same machine when unslotted. The writer recommends from $1\frac{1}{2}$ to $2\frac{1}{2}$ pounds per square inch of cross section on stationary machines, from 3 to 5 pounds per square inch on crane motors, and from 4 to 8 pounds per square inch on railway motors.

In conclusion, it may be said that the successful operation of slotted commutators depends largely upon three factors: First, the thoroughness with which the slotting is done; second, the selection of the proper brush; and, third, periodic, careful inspection.

Correction: On page 210 of the May issue, the second sentence of the last paragraph in the first column reads: "By abrasiveness we mean the scouring or cutting qualities of a brush which does not in any way depend upon its hardness and may be determined by cutting the brush with a knife or by marking with it on paper." This statement should read as follows: "By abrasiveness we mean the scouring or cutting quality of a brush which does not in any way depend upon its hardness. The hardness of any brush may be determined by cutting it with a knife or by marking with it on paper."

Some Problems Met and Solved by an Electrical Trouble Man

BY J. A. HORTON.

IF a desk lamp fails while in use, the average man will not hesitate to tighten the lamp in the holder-socket, or to tighten the plug in the wall socket, or to inspect the lamp filament for breakage, or even to note if other outages indicate that the service fuses have blown; in other words, he soon becomes a trouble man on lamps, flat irons, cooking utensils, buzzer and bell circuits, and other domestic conveniences. For recreation the business man gets an automobile or a gasoline launch, and within a year he is able to promptly diagnose any of the minor troubles most likely to characterize such machines. He automatically qualifies to help himself, because on so many occasions his troubles occur when there is no one to help him.

When it comes to locating troubles in motors in an industrial plant, however, even a good mechanic in other than electrical lines and many electricians find themselves in a state of wondering what to do. The mystery supposedly for so long to be associated with things electrical seems to discourage efforts of many able men to save time and money by making a search for electrical troubles when they appear at all serious in many cases. The same good sense and judgment that make such men a success in their business could be used to advantage. Where expert help is reasonable and is within prompt and easy access, it may not pay a superintendent to do his own investigating, but more often what is most needed is brains on the job. In such a case time and money, and, what is more important, delays in production, can often be saved by a common-sense inspection of the motor, its starter and of the wires leading to them. Unless a demonstration has attended the stopping of a motor or attempted efforts to start it, the failure in many cases will be due to some surface trouble, such as a blown fuse, or to a switch that has shaken open, or to a burned-off wire, or to loose parts or connections that may be easily seen and that need only a careful eye to see them. The desirability of such a common-sense inspection applies more particularly to isolated industries, where one good man of sound judgment is in charge of every detail of the business. In what follows under the heading of Some Problems Met by an Electrical Trouble Man, the irregularities cited and their solutions should seem commonplace and evident to one well versed in electrical matters, but to one little versed they are intended to be a help, and they will be if read by those for whom they are intended—namely, operators that have no skilled help and ambitious help that is not skilled.

OVERLOADING MOTORS.

No single condition causes more serious generator and motor troubles than overloads, and as the condition may obtain gradually, overloads are likely to cause serious trouble before they are realized. Old machine designs were largely based upon guesswork, in which the engineer was liberal in order to make the guess safe. Now that designing is an exact science, a manufacturer furnishes exactly what is specified and for what the purchaser may fail to consider that he must pay for. Set an old, slow-speed unit alongside of its modern high-speed equivalent and the comparison is bad for the new machine, unless one considers price, and an operator unfamiliar with changed conditions will continue to add work to new machines as he was accustomed to add it to old timers.

In the case of a generator, the ammeter may be a saving feature, but as motors seldom have ammeters, all judgment of load is suspended until the motor begins to spark or to smoke. With the old machines, sparking limited the maximum safe load, and it could often be taken as a fair criterion of load conditions. With modern commutating pole machines, however, heating is the limiting feature, and a machine may operate for months at a temperature that is slowly deteriorating its insulation, and without the brushes giving any warning of the dangerous conditions. Someone is usually sufficiently interested to put meters in circuit with the machine—that is, starting its connected load for the first time—but thereafter all interest seems to end. Before adding to the connected load of any electric motor, therefore, readings should be taken to ascertain if the added duty is going to overload the motor to the point of excessive heating.

GENERAL FUSE BLOWING.

To one familiar with the liability of fuses to blow, the blowing of a fuse is a small matter, excepting insofar as the cause of the blowing may be interesting. To the many who are daily adopting electric drive for the first time, and without experienced operating supervision of any kind, the blowing of a fuse may be a calamity from a production point of view. This is evidenced by the frequency with which inspectors are called long distances, only to find that failure of a motor or generator to deliver energy is due to a blown fuse.

To make matters worse, the tell-tales of enclosed fuses are not an infallible indication of the condition of a fuse. The tell-tales are supposed to disrupt or to at least discolor when the fuse operates, but sometimes they do neither, with the result that it is an easy matter to get good and bad fuses mixed in a box that is supposed to contain only good ones. The only way to positively tell whether a fuse is good or not, if it is of the enclosed type, is to test with a bell, magneto or a lamp circuit. On rare occasions even this test may be misleading, because if the fuse was defective in the first place, and the tell tale was not, the tell-tale will carry the test current, where it will blow as soon as a working current is applied. In a case in mind an inspector responded to a call to locate an open circuit in the hoist motor of a crane, idleness of which would tie up a whole foundry during pouring time, which was near. The crane man stated that the crane had "lost the power," and that he had located a blown fuse, which he had replaced, but that replacing the fuse had not helped matters. The inspector concluded that there was a ground that had quietly blown the second fuse the same as it had blown the first one. On testing for a ground, however, the circuit tested clear. He next opened the controller and moved the cylinder on and off to observe which fingers showed flashes, and he quickly noted that only two of the four fingers representing the two legs of a three-phase circuit showed any life. One leg was then open-circuited, and application of the test circuit traced the break right to the fuse that the crane man had used for replacing the blown one. As this fuse had been taken from a box of new ones and showed no evidence of defect, the crane man was justified in assuming that it was a good one. When a D. C. armature fails to take current, or an A. C. rotor simply stands still and hums, the first place to look for trouble is in the fuse; the fuse as a whole may be loose, or the fuse-metal may be melted or otherwise defective.

ERRATIC MOTOR SPEED.

In the manufacture of fine instruments and of precision tools, it is essential that the speed of the working tools be maintained constant, otherwise machined surfaces will not be absolutely true all the way across the cut, and parts intended to fit perfectly will not do so. Men engaged in such work are, as a rule, gifted with judgment that extends well into other lines of work, so it was not much of a digression for the foreman of a transit factory to suspect that "waves" in the work produced in one of his departments were due to motor speed variation. Speed variation was not perceptible to the ear, even when all noise-making operations in the room were suspended. As all other motors operated from the same service lines were acting normally, it could not be a matter of supply voltage variation. As all pulleys were cool, there was no indication of belt slippage. Motor brush tension was also good; brushes were set correctly, with commutator smooth, but hot and sparking a little, but brush shifting made no material difference. All other parts were cool and connections good. The chances of overload seemed small, but an ammeter was cut in circuit to find out what it would show, and it promptly showed the trouble, for its needle jumped "all over the lot." The steady current required by the connected load was about 30 amperes, but the ammeter needle fluctuated between 20 and 50 amperes in nervous jumps. Notwithstanding the fact that the commutator appeared to be perfectly smooth to the eye and to the hand, the trouble was due to high mica. Turning and grooving the commutator eliminated all troubles.

A SPARKING ROTOR.

The bars of squirrel cage rotors may be electrically welded, bolted or soldered to the end rings. The welded construction is the most permanent, especially under con ditions of abuse. The bolted construction requires attention; otherwise expansion and contraction, due to alternate heating and cooling, will loosen the bolts. The hardest of solder is used in soldered rotors, but continuous abuse will melt it out. An inspector was once called to prescribe for a three phase induction motor that "was not behaving right." The motor was connected to a paint mill pulverizing roll that was started and stopped often. A glance at the rotor in operation showed at once that the trouble was melted solder, because the scenic effect was that of a big pin wheel. It was most intense at starting, but maintained considerably in steady operation. An ammeter connected into the running side of the compensator showed that the running current was within the motor's rating. The meter was too low in capacity to connect it into the starting side. It later developed that the compensator had a finger missing on the starting side for several weeks, and that during that time the motor had been started by throwing the compensator to the running side. What the starting current may have been when the rolls were jammed is a matter of conjecture, but that it was sufficient to melt the solder from the rotor in about a week was certain. To remove the rotor, repair it and reinstall it was a matter of three days. To replace the missing compensator finger, which should have been done in the first place, would have been a matter of but a few minutes.

In another section of this article other troubles of this kind will be taken up.

1914 Convention American Electric Railway Association.

The 1914 convention committee of the American Electric Railway Association, acting with the committee of the American Electric Railway Manufacturers' Association, has chosen Atlantic City as the location for the 1914 convention. The dates are October 12th to 16th.

The decision of the committee was arrived at after a careful investigation of several other suggested locations, Boston and Washington being the leaders among the applicants, but neither of these cities could furnish the accommodations necessary at the time required.

The association's conventions are growing so large that both from the standpoint of hotel accommodations and a place to house exhibits, available locations are each year growing fewer. It is known that Atlantic City can take care of the convention, and the history of the association shows that those held at Atlantic City have been uniformly successful. Last year's arrangement at Young's Million-Dollar Pier wa sadmirable, and with the prospect of the use of even more floor space this year, ample room will be available for the exhibits of manufacturers.

Practical Considerations When Wiring Old Buildings.

BY G. N. MATHIS.

Methods That Make Possible a Neat and Substantial Wiring Job.

When installing electrical wiring in old houses, neat and substantial work is a good advertisement for both the electrical contractor and the central station. The house owner generally considers wiring an already constructed house, which may be nicely finished, as a difficult matter and liable to cause injury or defacement to wood work and floors that will be ugly ever afterward or until repaired. That such is a mistaken idea has been proven in many cases where electrical contractors have made a study of the problem and endeavor to install a neat job. This fact alone has been responsible for permission to wire houses that otherwise could not have been approached. In what follows the writer takes up a few considerations that should be of interest to an electrical contractor working on old houses.

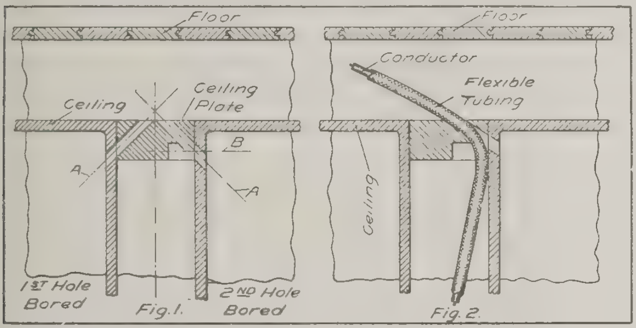


Fig. 1. Boring Holes in Ceiling Plate for Fishing Loom. Fig. 2. Loom and Conductors in Final Position.

The manner in which a conductor can be fished from a ceiling space into a partition space without cutting a large pocket is shown in Figs. 1 and 2. It is necessary with this method to bore only a couple of holes into the wall of the room near the ceiling, but these need not be larger than one inch in diameter, and they can readily be plastered up and papered over, if wall paper of the proper pattern is available. After the work has been done properly, it is practically impossible for a person standing on the floor to detect where the holes were bored. The first hole is bored as indicated at *A*, Fig. 1, diagonally from the room up into the ceiling space. Another hole, shown at *B*, Fig. 1, is then bored so that it will go through the lower edge of the ceiling plate. By proper fishing, the loom-covered conductor or flexible cable can be drawn into the wire-way, provided as just described, so that it will assume the position shown in Fig. 2.

In wiring old buildings of frame construction, a great deal of loom-covered conductor must be used; and, to satisfy the underwriters' requirements, this conductor must be continuous from support to support, and from outlet to outlet, which precludes the making of joints or splices in partitions or ceiling spaces. When steel armored conduit is used, it is continuous from outlet box to outlet box, and taps can be made in the wall boxes for bracket outlets. In order to meet the underwriters' requirements, where a circular loom-covered conductor installation is being made, it is often necessary to wire for a bracket outlet, as shown in Fig. 3. A separate tap must be brought down from the support in the ceiling space above to the outlet, even though a conductor, which ordinarily might be utilized, drops down through the partition to the floor below. This feature of old-building wiring is important and is frequently overlooked until the wiring inspector investigates, when he may require a rearrangement of the conductors so that the work will meet the requirements of the Code.

A good method of supporting a wall-switch box is shown in Fig. 4. After the outlet hole is cut in the wall, the wooden switch block, which is a commercial article, is supported against the wall surface with flat head wood screws. Frequently the support provided by screws merely turned into the laths imbedded in the wall is not sufficiently substantial. In such a case wooden cleats can be introduced into the space within the partition, as shown in Fig. 4, and the wood screws can be driven through them. This arrangement will be found entirely satisfactory. The wall switch box, after the conduit is made up into it, is then inserted into the hole in the switch block and secured to the block by flat-head wood screws, which pass through the lugs provided on the box.

Another method of supporting a wall outlet box which can be used for switch boxes, but which has been most frequently utilized for bracket boxes, is detailed in Fig. 5. The hole in the wall surface should be cut just exactly the right diameter to admit the box. A crowfoot should then be fastened against the laths on the opposite side of the partition, so that its center will coincide exactly with the center of the outlet hole. Prior to fastening the crowfoot, there should be screwed into it a nipple of such a length that about one-fourth inch will extend through the bottom of the outlet box when it is in place. A lock-nut is run onto the nipple, and the conduit is made up into the box and the box pushed into its position in the outlet hole and over the nipple. An insulating joint, which is necessary for supporting the fixture, is turned on the portion of the nipple

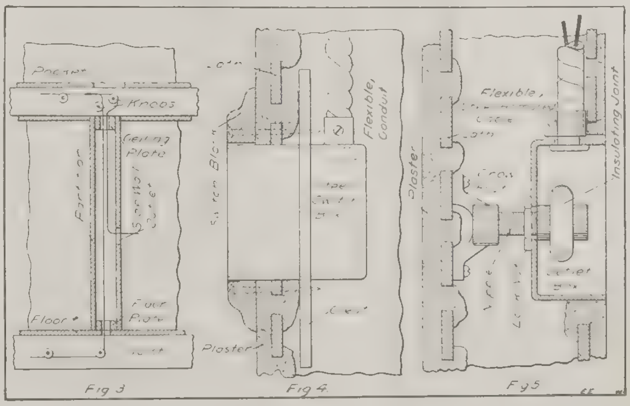


Fig. 3. Conductor Arrangement to Satisfy Underwriters' Requirements.—Fig. 4. One Method of Mounting Partition Switch Box.—Fig. 5. Method of Mounting Box for Bracket Electrolier.

that extends through the bottom of the box. A very solid support will be thus provided for the bracket if the outlet hole has been carefully cut through. If the outlet hole is too large, the support will not be solid, because a good portion of the rigidity that should obtain is provided by the box bearing against the sides of the outlet hole.

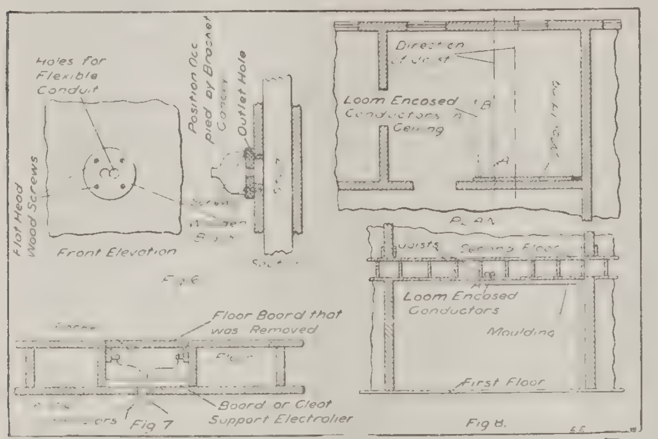


FIG. 6. MOUNTING BLOCK FOR BRACKET IN POSITION.—FIG. 7. MOUNTING BOARD FOR ELECTROLIER.—FIG. 8. CONDUCTORS CARRIED IN MOULDING TO ELECTROLIER.

Where a bracket is to be supported in an installation where loom-covered conductors are being used, the method suggested in Fig. 6 is probably as good as any. A round wooden block is secured over the outlet hole, to the side wall, with long, flat-head wood screws, which should pass entirely through the plaster into the lath. If the support provided by screws turning into the lath is not sufficiently rigid, cleats may be arranged in accordance with the method outlined in connection with Fig. 4. The crowfoot supporting the bracket is held with wood screws to the block. The sectional drawing of Fig. 6 indicates the position the bracket canopy should assume after the installation has been completed.

Where electroliers are to be installed in connection with a circular loom wiring job, cleats should be provided over every electrolier outlet, as indicated in Fig. 7. The crowfoot supporting the electrolier should be fastened to the ceiling with long, flat-head wood screws, which should pass entirely through the plaster and into the cleat provided for their reception. Crowfeet have a tendency to dig into the plaster when they are clamped to a ceiling with screws. One way to prevent this is to fasten at proper locations sheet metal discs, having holes for the circular loom and for the screws drilled in them. The discs should be of such a diameter that they will readily fit within the electrolier canopies. The areas of the plates should be sufficient, that the pressure due to the screws holding the crowfeet will be distributed over a considerable surface. A substantial attachment will thus be effected and the electrolier will hang plumb.

Moulding can be effectively utilized where it is not possible, for one reason or another, to fish within partitions. Fig. 8 illustrates a typical application of this character. The conductors are carried from the floor below, up one corner and around the ceiling of the room in moulding, and then are fished from this point, as shown in (*A*-1), Fig. 8, to the electrolier outlet *B*, in the center of the room. In many rooms the presence of moulding would be objectionable, while in others it would not. It is frequently possible for the wireman to install conductors in moulding as described and thereby eliminate the excessive cost of fishing conductors, which is to be expected where all wiring is concealed. Fig. 9 shows in detail how the loom-covered wires from the side wall to the electrolier outlet should pass down through the ceiling and into the moulding. An "L"-shaped piece should be cut out of the moulding as indicated to accommodate the ends of the circular loom.

Circular loom should be continuous on the conductors from outlet to outlet, as shown in Fig. 10-II. Fig. 10-I is included merely to demonstrate how it should not be done. Wiremen of little experience sometimes place lengths of loom on a conductor only at the points where it passes through outlets (Fig. 10-I), while the external appearance of methods (I) and (II) is the same, the wiring inspector can readily determine the existence of the pieces of loom in the makeshift (shown at I) by grasping the loom in one hand and the conductor in the other and moving the conductor within the loom. If the loom is continuous from outlet to outlet, as it should be, he cannot move the wire within it; whereas, if only short lengths of loom are used at the outlets, the wire can be moved. This condition enables the inspector to readily detect the infringement of the rules.

For exploring—that is for boring a very fine hole through a floor, wall or partition to ascertain just where a large hole, started from one side of the obstruction, will come out on the other side—a home-made bit, illustrated in Fig. 11, is a very convenient tool. The bit consists of a piece of steel wire, possibly 6 or 8 inches long, having one of its ends filed to a drill point, similar to the point of a brad awl, and at the other end enough wire bent back and forth upon itself to form a shank that the chuck of a bit-brace will engage. Umbrella ribs can be used for this service, or the coppered steel wire that is usually procurable in hardware stores can be employed. Such a bit will cut rapidly, and, if a sufficiently small one is used, the holes left by it will be so small that they will be difficult for the house owner to find

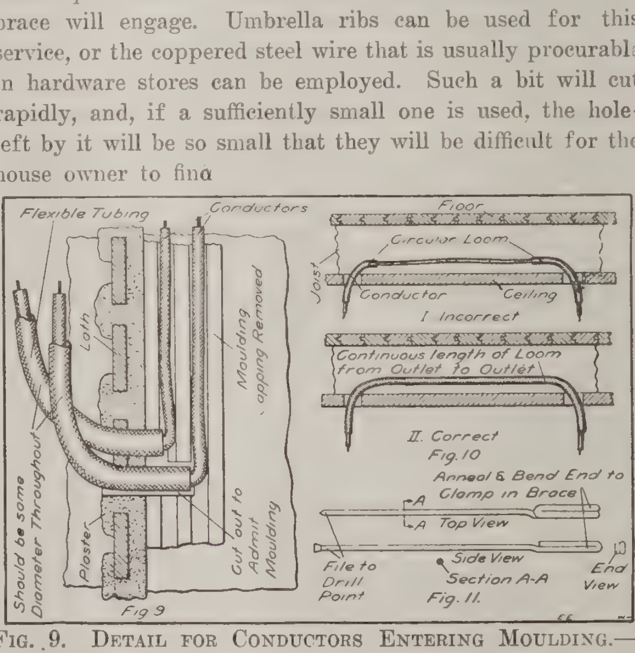


FIG. 9. DETAIL FOR CONDUCTORS ENTERING MOULDING.—FIG. 10. METHODS OF ENCASING CONDUCTORS WITH LOOM. FIG. 11. DETAIL OF EXPLORING BIT.

A tool for cutting the tongues from the floor boards that are to be removed can be readily constructed by any old-building wireman from a sheet steel carpenter's scraper of the sort that is sold at any hardware store. In use the scraper is driven down into the cracks between the floor board that it is decided to remove and the adjacent board. Driving down the "cutter" splits off the groove from one of the boards. The groove is then split from the other side of the board in the same way, after which the board can be readily pried up with little disfigurement to the floor.

Convention of Georgia Electrical Contractors' Association at Macon, Ga.

The second meeting of the Georgia Electrical Contractors' Association, held at Macon, Ga., on May 26th, made plain two things: First, that the contractors in the state of Georgia have determined to co-operate with each other in a business-like and mutually beneficial way for the purpose of elevating and properly promoting the electrical contracting business throughout the state. Second, it showed that selfish aims and motives have been entirely eliminated from the activity of the body, and that each and every member is ready to face affairs as they actually are and arrange together a solution of the difficulties, whether technical, financial or commercial, in connection with every line of the electrical contracting and supply business. Some forty members of the association, jobbers and manufacturers, were present, several new members attending the meeting for the first time. The sessions were held in the new Hotel Lanier at Macon.

The electrical contractors of Atlanta, Ga., made the trip to Macon by automobile. Five machines left Atlanta at 4 a. m. Tuesday morning, with Carroll McGaughey leading in his powerful two-passenger Buick, and "Gad" Russell, in his equally strenuous Cadillac pushing, Joe Clayton, Tom McKinney and Joe Bryan being between to stir up the dust, an accumulation of some six weeks without rain. This trip can best be briefly described by saying that 103 miles of fine country road were covered in three hours, much after the fashion of scared rabbits, with no accident, and consequently no lives lost.

The convention was called to order by President R. M. Walker, Walker Electric Company, Rome, Ga., promptly at 11 o'clock. After roll call, papers were read on the subject of "Co-operation Between Central Station and Contractor," by William Rawson Collier, sales manager, Georgia Railway & Power Company, Atlanta.; H. J. Arnold, superintendent, Rome Railway & Light Company, Rome, Ga., and Gadson Russell, president, Russell Electric Company, a contractor of Atlanta, Ga. Abstracts of these papers follow:

PAPER BY WILLIAM RAWSON COLLIER, SALES MANAGER, GEORGIA RAILWAY & POWER COMPANY.

In his opening remarks Mr. Collier referred to the good work being done by commercial organizations, such as the National Electric Light Association, the Illuminating Engineering Society, the Society for Electrical Development, the Jovians, and the National Electrical Contractors' Association, in bringing together those interested in the electrical industry in such a way that all who are earnestly co-operating will profit by their efforts. In regard to co-operation he said:

"I cannot conceive of where the idea first started that there should not be active co-operation between electrical contractors and central stations. Of course, it is true in a great many cases that central station managers or the electrical contractors in a certain locality are short-sighted, or that some grievance has come up that has not been adjusted, and thus the lack of co-operation crept in and the seed of disruptive competition been sown.

"As for co-operation and the ways and means thereof, my experience up to about a year and a half ago covered only Atlanta. Here I know practically all of the electrical contractors; we see each other often and there has grown up between us what might be called a family feeling. Since April, 1913, I have had the pleasure of meeting and co-operating with the electrical contractors working in about twenty-five towns in the northern section of the state. In not a single case has there been a particle of friction, as our company's reputation has gone ahead of us, and the contractors know that they will get a square deal if they give a square deal in return.

"As to how we have co-operated with our contractors and boosted their business, I will mention briefly several specific plans that have been worked out. First, through the various boards of trade, chambers of commerce and trade journals we are constantly in touch with all new manufacturing plants to be erected in our territory. Naturally, in soliciting the sale of electrical power we meet those in charge generally before the plans and specifications are prepared. After signing the business we suggest to the customer that he can no doubt save money by having the local electrical contractors bid on his work, and we offer to see that his plans and specifications are placed in the hands of responsible local bidders if they are sent to us. In almost every case the customer sees the correctness of this suggestion, and at the present time I believe that wiring plans of two large branch factories being erected in Atlanta territory by a foreign corporation are in the hands of local contractors for figuring.

"Second, the company has run, and expects to run again at an early date, an old house wiring campaign. We now have a card index showing practically all the houses situated on our electric lines in Atlanta that are not wired for electricity. From the manufacturers and through the commercial section of the N. E. L. A. we have obtained some splendid booklets on old house wiring. These booklets are sent by mail to each prospect, four booklets and a personal letter constituting the campaign. After the campaign is fully launched the mailing list is to be divided up among the electrical contractors, each name being referred to at least two contractors. The contractors will then be in a position to easily close the business.

"In the smaller towns served by the company we have used advertisements in the local papers, which are educational in nature and call attention to the fact that electricity can be used for other purposes than lighting, mentioning cooking, washing, ironing, cleaning, etc. These advertisements are signed by the name of the local contractor who is to reap the benefit. The Georgia Railway & Power Company inserts the advertisement and pays for it.

The special mail campaigns and newspaper campaigns mentioned are supplemented by advertising sent by mail to those who are in need of electric service. At this point Mr. Collier described the recent canvass of the city of Atlanta to secure information on whether or not the houses were wired for electricity, and, if so, what devices could be used, which canvass, together with the nature of the information secured, was fully described in the May issue of Electrical Engineering.

The value of the information secured by such a canvass, and the efficiency of the information when worked into a card index system was shown through reporting the results of three recent campaigns which have been based upon the information thus secured. In three weeks $1,200 worth of electric vacuum sweepers have been sold by means of a list of names shown by the index as prospects for this apparatus. In one month 25 gas water heaters have been sold based on a list similarly compiled. In the first three days of a campaign started May 21st approximately 275 gas flat-irons have been sold. During the month of April approximately 19,000 pieces of mail matter were sent out, and during May this number will probably reach 35,000.

As an example of co-operation between central stations and electrical contractors, Mr. Collier referred to the illumination in Atlanta during the recent Shriners' convention, May 11 to 16. In installing this illumination several of the company's tower wagons, with crews, were furnished the contractors to place the special decorations on trolley spans. One man was detailed from the sales department for a month to assist in designing and laying out some of the special decorations, and 13,000 lamps were loaned to the contractors for the decorative illumination. The heads of all departments assisted in every way possible during the opening night, the result of all this co-operation being that every visitor who was in Atlanta during the time mentioned went away with praise for the electrical effects produced. Views of the electrical decorations are presented herewith.

TALK BY GADSDEN RUSSELL.

Mr. Russell spoke for the contractors in regard to co-operating with central stations. He outlined the reasons for lack of such co-operation in the past, saying that most contractors were handicapped by lack of capital and unable to promote some of the current consuming apparatus in which central stations were interested. As the business has grown, however, the contractor has come to be a factor in providing outlets for current and so recognized by central stations He believes that the contractor should finance himself, and not depend upon the central station for help, when, under such conditions, he should be entitled to a profit on the goods he sells, and not be obliged to compete with the central station company.

Mr. Russell expressed high regard for the treatment accorded electrical contractors in Atlanta by the Georgia Railway & Power Company through Mr. William Rawson Collier as sales manager. He used this co-operation as an example of the support contractors should receive everywhere, closing by saying that the best interests of all are conserved by co-operation.

Mr. Arnold spoke on co-operation between central station and the contractor from the viewpoint of a general

Fig. 1. Georgia Electric Contractors at Macon Convention. Officers of Association Kneeling in Front, From Left to Right: T. H. McKinney, National Director; H. E. Lowe, Vice-President; W. L. Bailey, Treasurer; R. M. Walker, President; and J. M. Clayton, Secretary.

superintendent of a central station property. "The questions which naturally arise are," he said, "what is the need of co-operation, and what benefits do each of us derive?" In answering these questions, he explained some of the experiences of his company while carrying on an electrical contracting business for three years, saying that this end of the business gave more trouble than all the rest. The company does no contracting at present, all work being done by local contractors.

In reference to sale of appliances, Mr. Arnold expressed the opinion that contractors should handle same, and the central station, if handling such material at all, should sell at a profit. He said that efforts to make business profitable for the contractor bring returns by creating new business solicitors, and solicitors that can often secure business that the central station cannot.

In regard to advertising helps, Mr. Arnold said that his company and the local contractors take adjacent newspaper space, and when the local contractors are advertising products of special interest to the station, the space is given without charge for such display over the contractor's name. Circular letters and fliers are mailed with bills for the local contractors. He said, in conclusion, that whatever interests the contractor interests the station, and a co-operation must exist to intensively work the territory.

The discussion of these papers was taken part in by a large number of contractors present and many vital points brought out.

Ferdinando Levy, Levy-Morton Electric Company (Columbus), brought up the question of best ways and means for handling electric heating devices, and as to whether or not central stations are justified in selling same at cost to build up day loads when electrical contractors are in a position to handle same.

William Rawson Collier (Atlanta) replied to Mr. Levy by saying that in his opinion few cases exist where price-cutting in the sale of electrical heating apparatus by central stations is justified when contractors take an active interest in same. He said that there are exceptions however, on account of local conditions. In Atlanta, for instance, he explained that when the sale of heating devices was first taken up the matter was discussed with the contractors, who did not favor pushing same on account of the small profit to them; and the Georgia Railway & Power Company then took up the exploitation of these devices along the lines

Fig. 2. Decorations of Electric and Gas Building at Atlanta Shriner's Week.

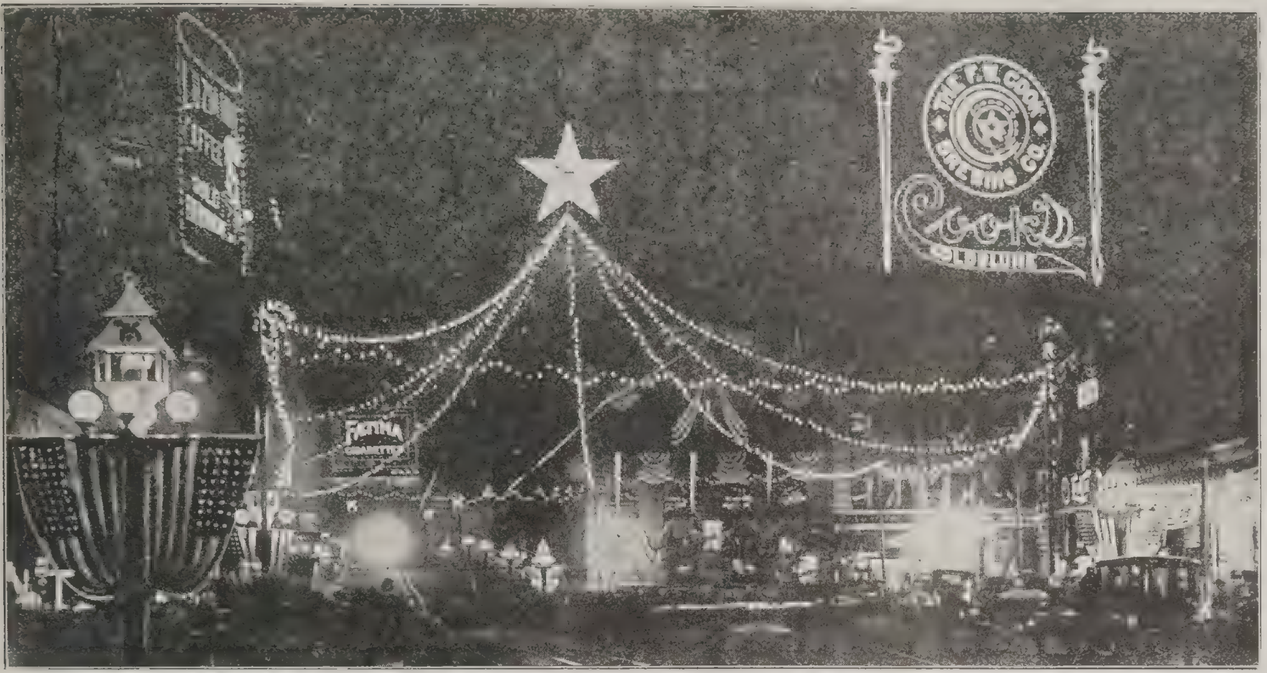


Fig. 3. Street Decorations in Atlanta Referred to in Mr. Collier's Address.

found best by the larger northern companies selling at low prices. This policy has not been followed with lamps. To introduce the tungsten lamp it was sold at a reduced price until manufacturers reduced the list prices, when a talk with electrical contractors showed that they desired the business, and lamps from that time have been sold by the company at list prices. This policy has worked out satisfactorily in Atlanta, and no reduction in lamp sales has been felt, while the contractors have secured the largest share of the business. He stated that at present not more than 5 per cent of the tungsten lamps now used in Atlanta are sold by the central station. The company further does not take a motor agency. Mr. Collier closed by saying that his company was in the business of selling electrical energy, and not apparatus.

Sylvan Byck, Byck Electric Company (Waycross), said that the central station in Waycross advertises the sale of heating apparatus at list prices, the contractors making the sale. He believed that this situation can be satisfactorily handled by the contractor. Heating apparatus is sold on the installment plan, the contractor securing the contract and turning over same to the central station at a discount of 10 per cent from face value for collection.

Mr. Collier called attention to department stores, hardware stores, etc., selling heating apparatus over the bargain counter, and expressed the opinion that more trouble will be experienced from manufacturers making contracts with this class of retailer than from price-cutting by central stations.

R. M. Walker (Rome) said that proper advertising in regard to repairs of heating apparatus by contractors and dealers would, in his opinion, eventually hold the business among local electric dealers.

H. E. Lowe, Lowe Electric Company (Macon), took up the subject of house wiring campaigns as conducted in Macon, stating that contracts were made by the contractors, the contractor being paid by the central station, which, in turn, billed the customer and collected in installments covering twelve months.

Mr. Hall, of the Macon Railway & Light Company, said further, on wiring campaigns in Macon, that such had been a decided success. The installations were made at prices agreed upon with the contractors, the customer being allowed to select better fixtures by paying any difference in price. Over 100 houses were wired on this plan, and another campaign is soon to be started.

W. C. Coles, Sprague Electric Company, (Atlanta), pointed out that his relations in a sales capacity with central stations and contractors where the one co-operated with the other had invariably shown that a larger volume of business is possible than in cases where such co-operation does not exist.

W. A. Justus, Baltimore Electric Supply Co., Atlanta, Ga., agreed with Mr. Coles, and further said that much good would come to central stations by furnishing contractors current without charge for display purposes.

At the executive session, held at 3:30 in the afternoon, a broadening of the scope of the organization was discussed and a motion made that contractors in neighboring states be invited to attend the next meeting. The idea brought out in this connection was to help extend the work in other states and perhaps assist in organization work should such steps be desired by those interested. The work to be done during the summer months was thoroughly gone over, and it was unanimously voted to hold the next meeting at Savannah, August 19.

Growth of Electric Vehicle Association.

The Electric Vehicle Association is maintaining the pace set for itself some months ago—namely, the acquisition of one or more new sections per month. At a meeting of the Board of Directors, held in New York Friday, May 22, the petition for a Los Angeles section was received and approved. Sections of the Electric Vehicle Association are now established in Boston, Chicago, Philadelphia, Washington, New York, Cincinnati, San Francisco and Los Angeles.

Good progress is being made with the program for the fifth annual convention of the association, which is to be held in Philadelphia on Monday, Tuesday and Wednesday, October 19, 20 and 21. The Bellevue-Stratford Hotel will be headquarters for this convention.

New Business Methods and Results

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

Convention Notes.

The commercial problems discussed at the recent convention of the National Electric Light Association are presented in some detail under the heading of "Commercial Sessions" elsewhere in this issue. In what follows, brief, non-connected notes and impressions are presented.

The present membership of the association, as compared with a year ago, is as follows:

	1913.	1914.
Class A	1,093	1,091
Class B	10,256	10,817
Class C	53	73
Class D	242	250
Class E	798	785
	12,442	13,016

The magnitude of the association work is well shown in the secretary's report. Nineteen thousand volumes of last year's proceedings were printed, 150,000 copies of the Bulletin, and 40,000 other publications, besides 180,000 copies of commercial section productions and 4,150 copies of the Meterman's Handbook. During the year 81 lectures were given, at which 1,000 lantern slides and moving picture films were used. The Question Box received 254 questions and published 1,296 answers to them.

The total revenue of the association during the past year was nearly $123,000. The running expenses were $84,000 and the convention expenses $34,000.

Important topics brought before the convention by President J. B. McCall were matters of public relations, rates, education of salesmen, and the welfare and safety of employes.

The exhibit hall was tastefully and comfortably arranged, and many of the delegates found it a very pleasant place to rest between sessions.

The success of the convention was due in a large measure to the co-operation of the Philadelphia Electric Company and their company section. This company has three generating and one reserve station, thirty-four substations, serves 55,000 customers, and has 2,500 employes on the pay roll.

The daily papers of Philadelphia showed an unusual interest in convention happenings and gave full and complimentary reports of all proceedings.

The commercial section elected the following as officers: Chairman, E. L. Callahan, Chicago; vice-chairmen, Douglass Burnett, Baltimore, and Jos. Becker, New York; secretary, C. A. Littlefield, New York, with Miss Gladys Burkhalter as assistant. The executive committee consists of Messrs. Beardslee, Edkins, Walton, Learned, McConnell and Wiedermann.

It was formally decided at the convention that "solicitors" are no longer to be called such, but salesmen. A committee was chosen to take up matters of terminology for commercial use.

Wednesday evening, June 3, was celebrated as the thirtieth anniversary of the first electrical exhibition in Philadelphia under the auspices of the Franklin Institute.

An interesting exhibit was arranged during convention week in Philadelphia at the Museum of Safety. Safety appliances and photographs illustrating use and methods of instruction were shown.

Electric Vehicles.

In the next issue will appear some facts and figures in regard to the electric vehicle, its field of application, costs of operation, plans for promoting its use, and arrangements which may be made for charging and proper care. The success or failure to interest truck users in the possibility of the electric vehicle hinges largely upon being able to demonstrate convenience as regards care and operation. While the electric vehicle is much simpler than the gasoline truck, it is not as common, and consequently not as well understood; and unless the possible purchaser can be assured of the co-operation of the central station in taking care of his truck, he will very likely not purchase one. To this end it would seem advisable for the central station to at least inaugurate an electric garage service even in average-sized towns, and continue to operate them until such time as owners of electric trucks can have skilled attention given electrics at other places. If this can be done, no doubt the central station manager will be glad to relinquish the charge.

In the case of pleasure cars, many owners prefer to do the charging at their residences. In such case the central station can arrange to give systematic battery inspection, see that the charging equipment is properly selected, furnish distilled water for cells, wash the cars if desired, and in general aid in every way possible to insure a satisfactory performance. A. G. Rakestraw.

E. A. Edkins, Sales Manager of Commercial Section, N. E. L. A., Outlines Residence Service Advertising Campaign.

The residence service advertising campaign, advance copies of which were exhibited at the Commercial Section headquarters at the recent convention of the National Electric Light Association, held in Philadelphia, is now ready for use by the member companies. It is believed that this residence service advertising campaign fills a field that has hitherto been somewhat neglected.

Many central station managers who realize today what splendid opportunities are lying neglected in the disproportionately large amount of unconnected business in their territories are pondering these three troublesome questions: (1) "How shall I increase the efficiency of my salesmen?" (2) "What are the best advertising methods for increasing the sale of current-consuming appliances?" (3) "How shall I get my unconnected 'prospects' down to the irreducible minimum?"

No more significant indication of the tremendous value of the Commercial Section's educational work can be found than in its convincing answers to these three questions, as set forth in the Salesman's Handbook, the report of the Merchandising and Advertising Committee, and the Residence Service Campaign. Every Commercial Section member has received his copy of the Handbood and has doubtless read the report of the Merchandising and Advertising Committee, but as many of the delegates at the convention were unable to see the few advance copies of the residence service campaign on display in the Commercial Section headquarters, a brief mention of this campaign may be of interest.

During the last three years, in answer to a widespread demand for "business-getting" booklets, the Commercial Section has issued eight or ten booklets, aggregating upwards of half a million copies, through its Publications Committee. A few months ago, however, it was realized that the most pressing need of the hour among our member companies was a "hammer-and-tongs" residence service campaign that would enable commercial managers to keep everlastingly after their unconnected residence prospects with rapid-fire publicity matter, covering a period of at least one year. Work was at once started on the preparation of this campaign, and the first edition is now in press.

This service comprises 13 separate pieces of advertising literature, including snappy, suggestive booklets, mailing folders, and facsimile letters with return cards, designed to cover a maximum period of twelve months, or to be mailed twice a month if necessary, space being provided on each piece of printed matter for the imprint of the local company making use of this service. The scheme is so flexible that large companies having their own advertising departments will find that this service may be dovetailed into their existing or prospective business campaign with the greatest ease and with the most gratifying results. Other companies who may lack the facilities of an advertising department, or who can hardly afford the expense of employing advertising experts to build up special campaigns, will find this residence service campaign a wonderfully effective and inexpensive solution of one of their most difficult problems.

It is perhaps hardly necessary to add that this material has been prepared under the supervision of some of the leading publicity managers of the central station industry—men who are experts in this particular line of work, and whose concentrated craft and experience in the gentle art of rounding up and corralling the prospective customer has been gratuitously contributed in the preparation of this campaign. Member companies of the association are offered this service at actual production cost, plus a small percentage for overhead expense.

Ross B. Mateer, Commercial Agent, Southern Sierras Power Co., Shows Value of Small Installation.

Considerable interest is now shown by small companies as well as the large ones in the exploitation of small current-consuming apparatus, including power apparatus of even less than 15 horsepower in connected load. It is being recognized more and more that a number of small installations are, as a rule, more profitable than a few so-called big propositions which may at any time prove hazardous to the successful and economical operation of plant equipment. This consideration applies most of all to the small company, where an improvement of load factor means increased dividends. An interesting discussion on the value of small installations was recently presented by Mr. Mateer in a paper before the commercial agents of the Southern Sierras Power Company, and in what follows some of the points brought out and data displayed by him are given. The paper was divided into three sections, taking up revenues of electrical equipment in agriculture, in city applications, and from electric vehicles. In commenting on irrigation pumping, where a small unit is operated over a long period of time each month, and providing an excellent load factor, the following table was given, which shows the Kw.-hrs. per month and per annum, and the revenue to the utility from such pumping. It was shown that any one of these installations could have been handled successfully with a pumping unit of not in excess of 7.5 horsepower, which, on a flat rate or even a load factor schedule, would have been more profitable, as shown by the comparison at the end of the table.

DATA ON PUMPING INSTALLATIONS.
SEASON 1913.

1.

Month.	H. P.	K. W. H.	Amount.
May	15	670	$ 16.75
June		741	18.50
July		944	23.60
August		1112	27.80
September		960	24.10
October		601	15.00
Totals		5028	$125.75

2.

Month.	H. P.	K. W. H.	Amount.
May	15	1388	$ 34.70
June		77	15.00
July		428	15.00
August		187	15.00
September		437	15.00
October			
Totals		2517	$ 94.70

3.

Month.	H. P.	K. W. H.	Amount.
May	20	1027	$ 25.65
June		938	23.45
July		603	15.05
August		1775	44.35
September		1278	31.95
October		587	15.00
Totals		6208	$155.45

4.

Month.	H. P.	K. W. H.	Amount.
May	25	1110	$ 22.20
June		1730	34.60
July		2420	48.40
August		2670	53.40
September		1710	34.20
October			
Totals		9640	$192.80

5.

Month.	H. P.	K. W. H.	Amount
May	15	50	$ 15.00
June		170	15.00
July		450	15.00
August		880	22.00
September		620	15.50
October		540	15.00
Totals		2710	$ 97.50

6.

Month.	H. P.	K. W. H.	Amount.
May	20	1150	$ 28.75
June		1470	36.75
July		1170	29.25
August		1040	26.00
September		1120	28.00
October		460	20.00
Totals		6410	$168.75

COMPARISONS OF PRESENT AND EQUIVALENT INSTALLATIONS.

	Present Apparatus.	Equivalent Equipment.
Average H. P.	18	7½
Average Mo. K. W. H.	903	3,937
Average Seasonal	5419	23,622
Load Factor	9.16	95
Average revenue per season	$137.49	$285.00
Average revenue per month	$ 22.91	$ 47.50

Other applications for current which the wide-awake commercial agent or superintendent can suggest to the farmer as a means of reducing his expenses and for the upbuilding of a valuable load for the power company are: Electric drive for shelling, grinding or cracking of corn; cutting fodder; threshing barley; separating milk; churning, working and washing butter; baling alfalfa, and others which suggest themselves to the alert salesman.

DATA ON FARM APPLICATIONS.

Operation.	Capacity of Machine Per Hour.	K.W. H. Per Bushel.	
Grinding Ear Corn..	40 bushels	0.411	per bushel
Rolling Oats	111 bushels	0.062	per bushel
Cutting Fodder ...	2 tons	2.08	per ton
Root Cutter	5.78 tons	0.158	per ton
Threshing Barley .	145 bushels	0.1257	per bushel
Churning Butter ...	100 gal. churn	0.617	per 100 lbs.
Hay Hoist	2,450 pounds	0.518	per ton
Horse Groomer ...		0.106	per horse
Washing Machine ..	3 washerfuls—36 sheets	0.0616	per washerful

In taking up applications in cities, ventilation was mentioned and an instance cited where one fan used in a post-office, moving 50,000 cubic feet of air on a demand of 1.25 Kw., represented a revenue of $22.50 per month based upon a 3-cent rate and operation of 600 hours per month.

The charging of electric vehicles as a profitable load was referred to by data on one garage caring for 22 electric trucks which use about 14,629 Kw. H. per month, or approximately 665 Kw. per truck. On a rate of 1.5 cents per Kw. H., the revenue per truck is $10.00 per month, while on other rates, based according to schedules applicable, a revenue per machine as high as $19.95 per month may be secured. In this garage the current is switched on at 10 p. m. and off at 7 a. m. Another instance was mentioned where the operation of 800 electric vehicles and 37 trucks on the streets of Denver calls for 2,000,000 Kw. hrs. per year for charging.

Work of Window Display Department of Society for Electrical Development.

A window dressing department has been inaugurated by the Society for Electrical Development, and a direct service in suggestions for seasonable displays will be furnished to members. Mr. A. J. Edgell, a member of the educational committee of the International Association of Window Trimmers and president of the New York Display Managers' and Window Trimmers' Association, will have personal charge of the work.

Windows will be trimmed and photographed, two photographs being sent to members, one showing the fixture setting and the other the finished window. Photographs of two such windows are shown in the accompanying illustration, the fixture setting being shown on the left and the finished windows on the right. Instructions as to how to trim the windows to secure the effects shown will also be furnished. Further information can be secured from T. M. Wakeman, general manager of the Society, 29 West Thirty-ninth street, New York City.

Brooklyn Gets Million-Dollar Contract.

The Edison Electric Illuminating Company, of Brooklyn, has just signed a contract with the American Manufacturing Company, the largest maker of bagging and cordage in the world, whereby the company will discard its 5,500 horsepower isolated plant and use central station service. The contracted load was for 4,000 Kw., the guarantee being for not less than 3,000 Kw. of demand, not more than 15 per cent of which is to come upon the peak. It involves a change from direct-current motors to three-phase, 25-cycle motors, and the scrapping of a $300,000 plant. The change-over will require an outlay of approximately $80,000, and the contract, which is made for a term of years, will give the Brooklyn Edison Company a gross aggregate income of between $1,000,000 and $2,000,000. To secure the contract required a trip to London, where the consulting engineers of the American Manufacturing Company are located, and a change in the regular labor schedule of the concern, which employs 2,000 men in its Brooklyn mills. The consumer agreed to close during November, December, January and February at 4:30 in the afternoons,

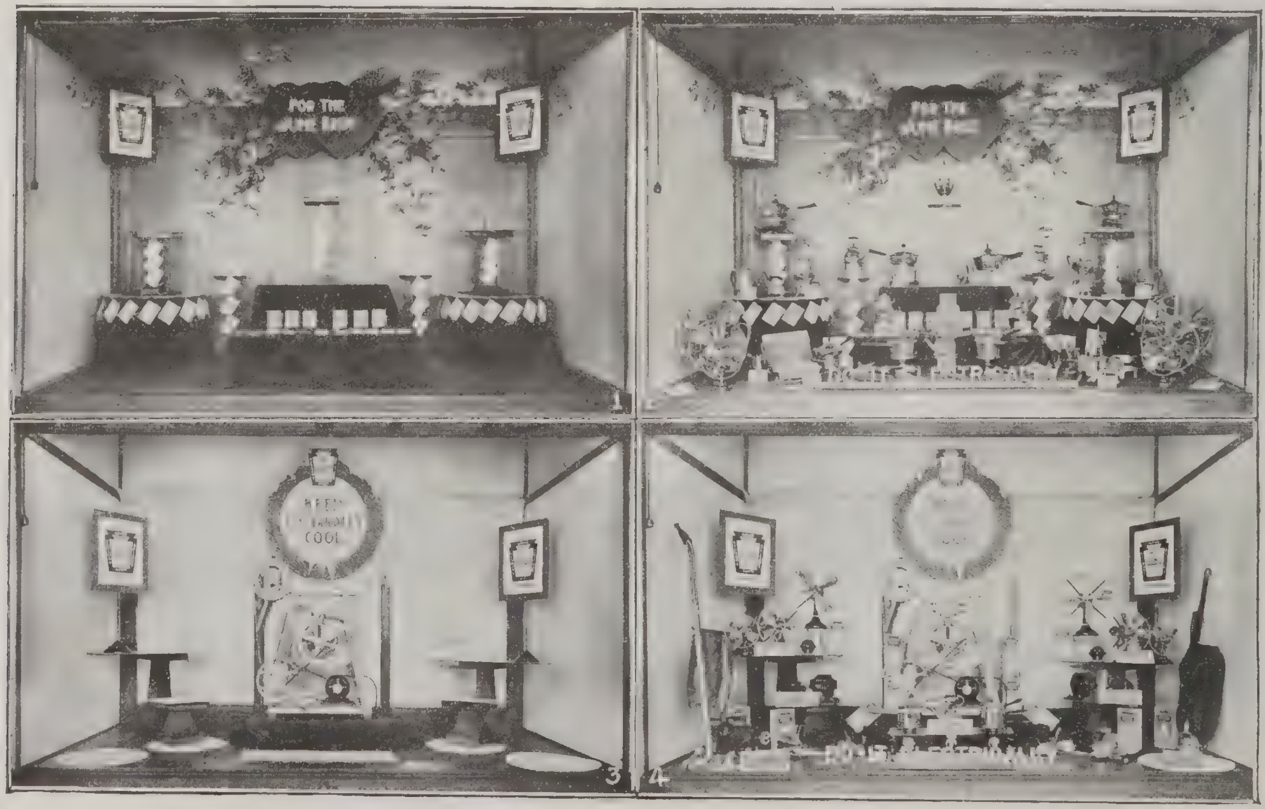
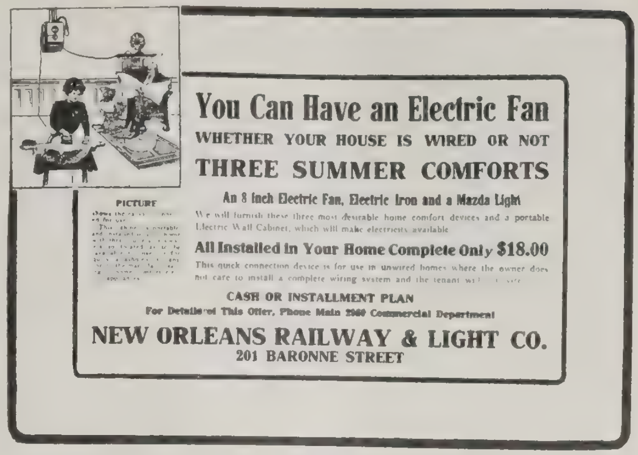


FIG. 1. VIEWS OF FIXTURE SETTING AND FINISHED WINDOWS FOR TWO DISPLAYS.

instead of 5:30, making a radical change in its labor schedule to take advantage of the central station contract, which is one of the largest covering strictly electrical service ever written.

Securing Small Customers in New Orleans.

The accompanying illustration shows an advertisement now being used by the New Orleans Railway & Light Company to interest and secure small consumers. Since the first of June over sixty of these wall cabinet installations have been made in non-wired houses, and at the present time W. E. Clements, the originator of the idea, advises that an average of nine outfits are installed per day. This scheme should appeal to the small company as well as the large one on account of the flexibility of the installation and its solution of the expensive house-wiring scare which holds back much of this business.



You Can Have an Electric Fan

WHETHER YOUR HOUSE IS WIRED OR NOT

THREE SUMMER COMFORTS

An 8 inch Electric Fan, Electric Iron and a Mazda Light

We will furnish these three most desirable home comfort devices and a portable Electric Wall Cabinet, which will make electricity available

All Installed in Your Home Complete Only $18.00

This quick connection device is for use in unwired homes where the owner does not care to install a complete wiring system and the tenant wi[illegible]

PICTURE

CASH OR INSTALLMENT PLAN

For Details of This Offer, Phone Main 2900 Commercial Department

NEW ORLEANS RAILWAY & LIGHT CO.
201 BARONNE STREET

Advertisement That Is Producing Results in New Orleans.

Questions and Answers from Readers

Readers are invited to make liberal use of this department for discussing questions, obtaining information, opinions or experiences from other readers. Discussions and criticisms on answers to questions are solicited. However, editors are not responsible for correctness of statements of opinion or fact in discussions. All published answers and discussions are paid for.

WHY DID TRANSFORMER BURN OUT?

Editor Electrical Engineering:

(463) Please advise if it would be practicable to connect a 20 and 30 Kw transformer in open delta to carry a load of about 25 Kw. The primary voltage is 2200 and the secondary 550. Such a connection was made and the 20 Kw transformer burned out. Please explain the reason as the connections were correct. Also give a vector diagram for the transformers under load to show the relations. Mac.

LIFE OF LAMPS ON DIFFERENT VOLTAGES.

Editor Electrical Engineering:

(464) The writer woul dlike to know how to figure the life of tungsten lamps on different voltages. That is, how much longer life will a 110 volt lamp have on a circuit of not more than 110 volts than on a circuit of say 112 volts? Will the life of the same lamp be longer on 108 volts than on 110 as rated? W. E. C.

DETERMINING PROPER CONNECTIONS FOR TRANSFORMER.

Editor Electrical Engineering:

(465) In case the terminals of the secondary winding of a lighting transformer have been changed and rearranged so that the beginning and ends of the coils cannot be located wit hcertainty, how can the proper terminals be determined so as to make a series connection? H. T. B.

LARGE D. C. MOTORS ON 110 AND 220 CIRCUITS.

Editor Electrical Engineering:

(466) Please explain in the question and answer columns why large direct current motors are usually operated on 220 volts instead of 110 if the circuit is large enough to carry the load? W. R. C.

USE OF CURRENT CONSUMING DEVICES ON HOUSE CIRCUITS.

Editor Electrical Engineering:

(467) When the proper fuses are installed for 3-wire feeded circuits with a grounded neutral for the system, and current consuming devices such as irons, heaters and vacuum cleaners are connected up to a maximum of 660 watts total, does this arrangement comply with the National Electric Code in regard to fuses? E. C. T.

Nature of Field of Single Phase Motor. Ans. Ques. No. 435.

Editor Electrical Engineering:

The stator of a single phase induction motor is entirely similar to the stator of a two phase induction motor. Phase *A* is called the operating winding and phase *B* the starting winding, which is automatically cut out as the motor speeds up. A suitable resistance or condenser is placed in series with phase *B*. The current in phase *A*, therefore, lags behind the current in phase *B*, and thus an imperfect (elliptical) rotating field is produced sufficient to start the motor. After phase *B* has been "cut out," the motor operates on account of winding of phase *A* only, but a rotating resultant field still exists.

This rotating resultant field is produced by two fluxes (ϕ and ϕ_1) at right angles to each other, the same effect as in a two phase machine. ϕ is the flux produced by the pulsations of the line voltage in the station, and ϕ_1 is the flux produced by voltage pulsations from the cutting of flux ϕ by rotor inductors. The fact that these two fluxes are at right angles to each other in the same material is entirely imaginary, but the effect is real. The proof of the existence of these two fluxes and a rotating field in a single phase induction motor is a very lengthy one and involves several diagrams. It can be found in any good text-book on alternating currents. Beaver's "Principles of Alternating Currents" contains a very clear and concise proof.

It is absolutely essential that all induction motors have their stator cores laminated. If the field or stator were made of the design of either the Edison bi-polar or the Lincoln square bi-polar machine, the hysteresis and eddy current losses would be too great for operation. Many small single phase fan motors have individual field poles similar to D.C. machines, however.

The magnetic field in an induction motor is exactly the same as would be produced by revolving the fields of a four-pole D.C. machine. H. R. Smith (N. J.).

Connections for Instrument Potential Transformers. Ans. Ques. No. 438.

Editor Electrical Engineering:

It is impossible to tell from question 438 what should cause the meters to rotate backwards, since in Fig. 3, for the primary connections, three leads are marked black and the connections at the meter are not indicated. In Fig. 3 it looks as though one transformer were reversed to compensate for an error elsewhere. This would change the direction of current in one potential coil, and while under some conditions of load it might give approximate results, yet it would not be correct. If transformers are so connected that the incoming current, or service, is connected to the red primary lead, then the secondary red is outgoing current and should be connected to the service side of meter.

The following is the simplest way to connect polyphase meters with current and potential transformers, and by following this method there is little chance for mistakes, while at the same time it protects any person from injury in case transformers are defective while working on meter. If the service feeds the primary of the current transformers through the red leads, tie the black secondary leads together, as the red secondary leads go to the service side of the meter. With the potential transformers, consider the current feeding from the outside legs through the transformers to the middle leg, so that if the red primary leads connect to outside legs, tie the black secondary leads together, and the red leads go to the service side of the meter. Tie the common points of the secondaries of both the current and potential transformers together and connect to all the terminals on the house side of the meter, the meter case, and to the ground. There are now left only four leads, two current and two potential, which connect to the service side of the meter, making sure that the current and potential from the same phase feed the same element of the meter.

The word "outside," where used above, refers to the line wires with current transformers, and "middle" to the line wire with no current transformer, and not to the position of the wires themselves.

With unity power factor on the line, each element of a polyphase recording wattmeter will record the same when connected one at a time if the load remains constant. With a lower power factor, one element will run slower, and below 50 per cent P. F. one element will record backwards. For this reason, in trying a meter with load to see if connected right, care should be taken that the P. F. of the line is above 50 per cent; otherwise, if it should record backwards and the connections be changed, it would be still wrong.

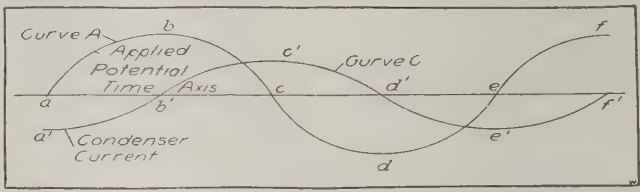
The mention of red and black leads refers only to transformers made by the Westinghouse Electric & Manufacturing Company. However, the above method can be used with all makes of transformers and meters.

J. G. Longfellow (Va.).

Action of a Condenser. Ans. Ques. No. 446.

Editor Electrical Engineering:

Whenever two conductors are separated by a dielectric, or insulator, a condenser is formed. The capacity of this condenser depends upon the area of the surface of the conductors, the distance between them, and the character of the dielectric. If we apply a difference of potential to the two conductors of a condenser, for a very short time there will flow into the conductors a current. This current is called the charging current, and its size and the length of time during which it flows depends upon the potential applied and the capacity of the condenser. Thus: Amps. × seconds = capacity × volts. Where the capacity is measured in farads. If having thus charged a condenser, we take a wire having resistance and connect together the two conductors, there will flow between them for a short time a current, heating the wire and discharging the condenser. This shows that the condenser stores up energy in the form of a charge when charged, and gives it up on discharge.



Curves of Emf and Current When Charging a Condenser.

If we should apply an alternating potential to a condenser, *i.e.*, a potential which rises to a positive maximum, (a) to (b) curve A, then decreases to a negative maximum, (b) to (d), repeating this cycle over and over, let us see what would take place. As the potential rises, (a) to (b), current begins to flow into the condenser conductors charging them, and so long as the potential continues to rise the current continues to flow, (a′) to (b′) curve C. When the potential reaches its maximum positive value at (b) the current ceases to flow (b′), and as the potential begins to decrease, the condenser begins to discharge, *i.e.*, send current back to the supply. This continues until the potential has reached its negative maximum when the outward flow of current ceases and the condenser is discharged, (b′) to (d′). Then the potential rises and the current starts to flow into the condenser again and continues until the potential reaches its positive maximum at (f) when the condenser is fully charged. This process continues and is repeated each cycle. From the foregoing it is seen that the condenser returns to the source on discharge, energy supplied to it on charge, so that although there is a current flowing into and out of the condenser there is little energy lost. It is also seen that the current flowing has a maximum when the applied potential is zero and that it is zero when the potential is a positive or negative maximum, thus the current wave leads the potential wave by ¼ cycle.

As stated before the value of the current flowing depends upon the capacity of the condenser and the applied potential, also that a condenser consists of two conductors separated by an insulating material. Thus a transmission line acts as a condenser and if open circuited with an A. C. potential applied to its ends, it is charged and discharged as explained above, the current flowing being known as the charging current of the line. Condensers used commercially are usually built up of plates of metal or tin foil separated by air, glass or waxed paper.

Nature of Induced Currents. Ans. Ques. No. 448.

Induced currents, so called, result from induced potentials in conductors either cutting or being cut by magnetic lines of force. The direction in which the potential is induced and thus the current caused to flow through the circuit, depends upon the direction of the cutting of the lines. There are two methods of getting this cutting effect. The first is by moving the conductor through a magnetic field or vice-versa, the field is moved by the conductor as is utilized in the generator. The second method is to place the conductor in a magnetic field which is constantly varying as is done in the transformer and the induction motor. In this case there may be no mechanical motion between the field and the conductor.

In order to induce a direct current in a conductor (potential always in the same direction) the cutting of the lines must always be in the same direction. This means that the conductor must move relative to the field to cut the lines as in a generator, for if the field was to vary it must always be either increasing or decreasing continuously which is impossible for any length of time. Devices in which direct potentials are induced are illustrated by the unipolar generator, and the foucault current brakes used on integrating watt-hour-meters. R. W. Goddard (Neb.)

Nature of an Induced Current. Ans. Ques. No. 448.

Editor Electrical Engineering:

An induced emf may be thought of as being produced either by the change of the magnetic flux enclosed by a coil of wire or by the cutting of the lines of force by a wire at a definite rate. These two actions are identical. The emf produced in the alternator is by the first method while that produced in the direct current generator is by the second method. Since induced currents are produced by induced emf's, they can be either alternating or direct according as the type of generator in which they are produced is of the alternating or direct current design.

D. G. McArm (N. C.)

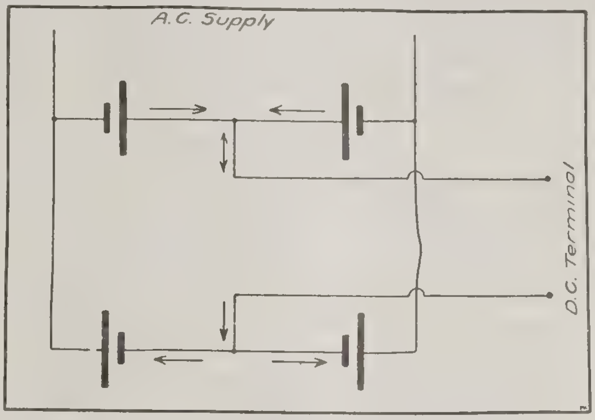
Nature of an Induced Current. Ans. Ques. No. 448.

Editor Electrical Engineering:

Induced currents are currents caused by the change in the value of other currents, and will be direct or alternating according as the primary current is direct or alternating. For instance the induced currents in transformers, and alternating machinery in general, are alternating and of the same frequency as that of the supply. If, however, we have a simple spark coil with primary and secondary winding and the secondary is short circuited with a battery current passing through the primary, there will be at the moment of closing the circuit an induced current, which will rapidly increase, then die away as the primary current reaches a steady value. This is a variable current but a unidirectional one. If now the primary current be broken, there will be another rush of secondary current, in the opposite direction. Probably the most important instance of this principle in direct current machinery, is that of self-induction in the field and armature circuits. The effect of this property is to set up strong opposition to change in current values. This affects the regulation and commutation of the machine, as well as makes necessary some provision for the dissipation of the energy liberated when the field circuits of large machines are to be opened.

Converters and Frequency Changes for Laboratory Use. Ans. Ques. No. 450.

Alternating current may be changed to direct current in small quantities for storage battery charging and the like, by means of four aluminum cells connected as shown. These cells have the property of allowing current to pass in one direction but not in the other. They are sold by the Electro-Importing Company of New York City, and other dealers in wireless and experimenters goods. Another type of rectifier is made by the Wagner Electric and Mfg. Co., and is of the interrupter type. That is one wave of the current is cut off by a contactor vibrating in synchronism with the supply current, giving a pulsating but unidirectional current. One half of the supply current is not utilized in this system unless two vibrators be used, one of which is arranged to reverse one wave and add it to the other one.



Connections of Aluminum Cells to Secure Direct Current From A. C. Supply.

A change from direct to alternating current is not so easily accomplished. If the questioner will write to the Fidelity Electric Co., of Lancaster, Pa., he will be able to secure prices on small converters of the rotary type.

A. G. Rakestraw.

Why an A. C. Wattmeter Hums. Ans. Ques. No. 451.

Editor Electrical Engineering:

The cause of the hum or buzzing noise in a watthour meter is due mostly to induction. The noise may be increased by loose laminatinos, jewels, or gear train. Also the meter board may act as a sounding board. Try mount-the meter on a more solid support with no hollow backing. The noise may be also lessened, but not entirely overcome, by changing position of permanent magnets, being careful not to throw meter out of calibration in so doing.

Calculation of Secondary Current in Wound Secondary Motor. Ans. Ques. No. 454.

There is no rule whereby one can determine the secondary voltage or amperes from the values given in the question. These values are best found from actual tests and use of the circle diagram or by writing to the manufacturers, sending serial number of motor. Generally the secondary amperes are stamped on the name plate of slip ring motors and this value is sufficient to determine the size of wire needed.

To operate a 60 cycle fan on a 25 cycle circuit, change the number of poles, using this formula: Poles $= (120 \times$ cycles $\div$ R. P. M.

Measurement of Power in an Unbalanced Circuit. Ans. Ques. No. 447.

Actual loads cannot be determined from voltmeter and ammeter readings, when the load is inductive, as I judge this load is; nor can the power factor be detremined. There is needed a wattmeter reading. The apparent load can be determined from this formula, $W = \sqrt{3} \times E \times I$. $E =$ voltage; $I =$ amperes; $W =$ watts. The value found from this formula must be reduced by the power factor to become actual load or power. The power factor in this case could be assumed as 80 per cent, but this is rather indefinite.

As the power factors of all systems is the ratio of the true watts to the apparent volt-amperes, you can readily see the readings of a wattmeter are quite necessary.

Clyde A. Turner (Mass.)

Why Watthour Meters Hum. Ans. Ques. No. 451.

Editor Electrical Engineering:

The humming of induction meters is due to the vibration of either the disc or the laminations, caused by the magnetism of the field coils. In construction this effect is broken up by clamping the laminations or impregnating them with some adhesive substance that has the same effect, and also by making the top bearing in two pieces, with rubber between so as not to transmit the vigrations to the frame.

In some types of meters, by removing the works from the case and tightening the screws holding the laminations, the trouble can be removed. Much of this trouble is caused by mounting meters direct on a hard plastered wall, which acts as resonator to amplify the sound. If impracticable to mount meter on a meter board, by using rubber washers under the lugs and a short piece of rubber tube on the screw, so that the meter case does not come in contact with the wall or the screw, the trouble can be modified.

J. G. Longfellow (Va.).

Nature of an Induced Current. Ans. Ques. No. 448.

Editor Electrical Engineering:

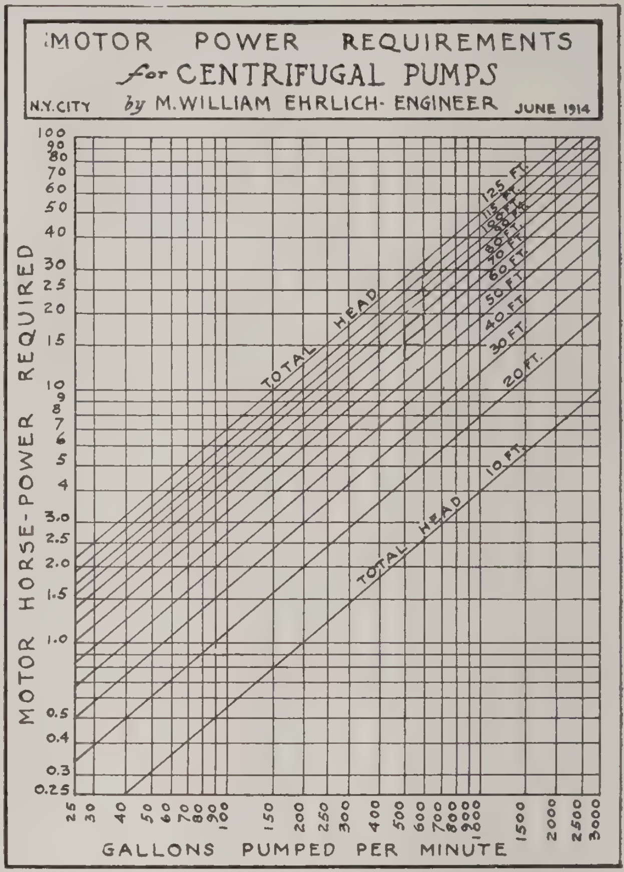
All induced currents are not alternating. Let us consider the simplest case of two parallel wires. If a current is set up in one, there will be an induced current in the other. If a direct current is set up in the first wire, there will be an induced current in the second as long as the first current continues to increase, and the size of the induced current will be proportional to the rate of increase. If the first current were to increase continuously for an indefinite period, we would have a constant direct current in the second wire. When the direct current in the first wire reaches its full value in a short time, as in ordinary practice, the induced current is only momentary, there being no current after the first current reaches a constant value. When the first current decreases to zero, the phenomenon is reversed and we have an induced current in the opposite direction. The rule is that the induced current is proportional to the rate of increase of the current.

In the case of an alternating current, which follows the sine law, the induced current is proportional at all times to the rate of increase or slope of the current, which follows the cosine law, or is the same as a sine wave 90 degrees behind the first wave. The proof of this is found by calculus, in that the first derivative of a sine wave is a cosine wave.

E. B. Billings, Jr. (N. Y.).

Motor Sizes for Centrifugal Pump Operation.

In answer to question 457, by W. J. R., referring to centrifugal pumps, we have had the diagram shown herewith specially prepared for Electrical Engineering by M. William Ehrlich, a New York engineer. With the aid of this data, the motor horsepower required for any combined conditions of capacity and head may be read directly on the left-hand scale. It should be noted that the figures given are not theoretical horsepowers, but are based on actual practice, and include the variable item of efficiency for both the volute and turbine types of pumps.



Power Diagram for Motor-Driven Pumps.

Centrifugal pumps are usually modified in design for specific conditions, resulting in numerous types of impellers, but, as a rule, each "stage" may be used against a total head of 125 feet; and by speeding up the machine can discharge against heads as high as 200 feet; but this is not desirable, and a multiple stage pump is therefore recommended. It is important that a centrifugal pump be operated as nearly as possible under the conditions for which it was designed; otherwise the motor may be heavily overloaded and other troubles experienced. A constant speed motor is recommended under constant load, but under varying operation a variable speed motor should be used.

The diagram shown is designed primarily for water purposes, giving the quantities in United States gallons. If other liquids are to be pumped, multiply the amount by the specific gravity of the fluid. The lines of total head represent the sum of the measured head plus the friction head, and are arranged in progressive order to 125 feet or the full tax on a single stage pump. Two stage pumps with similar impellers, and operating at the same speed as a single pump, will deliver the same quantity of water against twice the head and require double the motor power.

To use the diagram, determine the number of gallons to be pumped per minute, and follow the vertical line corresponding to this quantity on the lower scale until it intersects the diagonal line of total head, then read the motor size required on the left-hand scale. It should be noticed that the chart has logarythmic scales, and the figures should, therefore, be carefully observed.

Readers are no doubt aware of the fact that there is very little available data of this character, and are, therefore, advised to preserve this diagram for future reference, especially as no figuring is necessary to get at the results.—Editor.

A Condensing Plant vs. a Non-Condensing Plant.

Editor Electrical Engineering:

In reference to an answer to a question that appeared in one of your 1912 issues discussing the above subject, the writer desires to call attention to a few points that were not mentioned and may be of interest to others who have to investigate this problem in the future. The question referred to was stated as follows:

"Kindly present information on the following conditions. In our plant there is a 2,000 kw. turbine exhausting into a heating system about 140 days of the year. Will it pay to install a condenser for the remaining 225 days of the year? What would be the yearly gain or loss in dollars in case the condenser was installed? The labor cost may be assumed the same in both cases so that only coal cost, water cost, and charges against first cost of change need be considered. The turbine running non-condensing used 38 pounds of steam per kw. hr. The temperature of the feed water supply is raised to 210 degrees and the water cost is 13.33 cents per 8,300 pounds. The boiler pressure is 150 lbs. gage. Coal costs $3.00 per ton. The plant operates 10 hours per day."

The answer in the issue referred to fails to consider the necessary arrangements for cooling the water with a condensing outfit and it is believed on this account, shows too great a comparison in favor of the condenser outfit. The gain given through the use of the condenser for the above conditions is $13,335 per year. From what follows it will be seen that this figure is high.

The same assumption will be made as was made by the author of the answer for those conditions not named. Evaporation per pound of coal at 8 pounds. Since water is purchased, it is necessary to purchase condensing cooling water or drive deep wells which in either case is expensive. Only purchase of water will be considered. When operating 225 days non-condensing and the turbine exhausting to the atmosphere, instead of using 38 lbs. of steam per Kw.-Hr. as when the heating system is on with a back pressure of about 5 lbs., the steam consumption would be more like 28 to 30 lbs. per Kw.-Hr. Since a correction of evaporation from and at 212 degrees will be caught in the exhaust from the condensing apparatus, by charging up one of these machines with exhaust steam to heat boiler feed water, the 8 lbs. evaporation will be taken as the proper figure to use in the calculations..

Then we have, (2,000 × 30 × 10) ÷ 8 × 2,000 = $37\frac{1}{2}$ tons coal per day and 37.5 × $3.00 = $102.50 for fuel per day with the machine running non-condensing. Then (2,000 × 30 × 10 × 13.33) ÷ 8,300 = $9.64 per day for water to supply boilers. Total cost of fuel per day = $102.50 + $9.64 = $112.14 to operate the plant non-condensing.

Next we will see what it will cost to operate the plant condensing and then what it will cost to install condensers and if the difference would justify the investment. When running condensing at say 27-in. vacuum (any higher vacuum would be too expensive when water has to be purchased and cooling apparatus used) under these conditions and steam at 150 lbs. gauge pressure, we could expect abount 20 lbs. per Kw.-Hr. for the turbine. Then we would have,

(2,000 × 20 × 10) ÷ 8 × 2,000 = 25 tons coal per day. At $3.00 per ton, 25 × 3 = $75.00 per day for coal. Cost of water for boilers would be 2,000 × 20 × 10 = 400,000 lbs. per day, and adding 5 per cent to this for the condensing machinery, 400,000 + 20,000 = 420,000 lbs. per day. At $13\frac{1}{3}$ cents per 8,300 lbs., (420,000 × 13.33 ÷ 8,300 = $6.75 per day. Then cost of fuel per day = 75 + 6.75 = $81.75. The net saving by running the plant condensing over non-condensing per day is $112.14 — $81.75 = $30.39 and 30.39 × 225 = $6,837.75, the net saving per year.

From this amount we have to deduct the interest on first cost and depreciation, plus some other elements entering into the condenser proposition. The net result will then show whether or not one would be justified in installing the condenser. Since the barometric or low lift jet condenser will require about 25 per cent less water to produce the same vacuum, this type of machine will be considered. Although condensing water is being purchased, the condensate will mix with the injection water and be carried to the cooling pond or tower as the case may be. Since space may not permit the installation of a cooling pond of sufficient capacity to cool by natural means, we will have to figure on either a cooling tower or spray nozzles.

A jet condenser including circulating water and air pumps with either motor or turbine drive would cost erected about	$ 6,000
Cooling tower erected, including concrete basement	12,000
Pipe work over and above that required for non-condensing	3,000
First cost of installation of condensing apparatus, Total	$21,000

We will have to circulate not less than 2,000 gals. per min. of water over the cooling tower at a total head of 40 ft., therefore we will require a motor to operate the pump of 75 Hp. where the motor has an efficiency of 90 per cent and the centrifugal pump 60 per cent. Since this motor must drive the air pump (on the same shaft) which will handle about 10 per cent of the circulating water at less head, it will require an addition of 5 Hp., making 80 Hp. for motor rating. To operate this motor we would require 60 Kw.-hrs. at say $1\frac{1}{2}$ cent per Kw.-hr. at the switch board = 60 × 1.5 × 10 = $9.00 per day for current to operate condenser.

In addition to the evaporation that will take place in the cooling tower and which is taken care of in the boiler evaporation charge, we will have a natural loss for evaporization from sun etc., In addition to this enough water must be purchased to fill the basin for condensing purposes. For the size of tower considered about a 50,000 gal. reservoir is required from which to draw. From natural conditions this would evaporate at least once in 6 months making a cost of water amounting to 100,000 gal. per year in addition to heat evaporation. Thus, (100,000 × 13.33) ÷ 1,000 = $13.33 per year.

Cost of current to operate condenser equal 9 × 225 = $2,025.00 per year. Interest and depreciation on $21,000 at say 12 per cent = $2,520.00. We must then charge against the net saving the following items per year:

Water	$ 13.33
Current to run condenser	2,025.00
Interest and depreciation	2,520.00
	$4,558.33

Therefore we have a net saving of 6,837.75 — 4,558.33 = $2,275.42. While there are some items which we have not included in this discussion, such as additional oil, waste, etc., for operating the machinery, we have assumed that the same crew would handle the plant when running condensing as when running non-condensing, all of which could be true. It thus looks as if it would pay in this case to install the condenser and would pay over and above interest and depreciation about a 10 per cent dividend on the investment.

If the plant were a new one, the bleeder turbine could be installed and show better economies than given here.

Earl F. Scott. (Ga.)

New Apparatus and Appliances

Street Lighting Fixtures.

A new line of street lighting fixtures which combine artistic appearance with efficiency has been produced by the George Cutter Company, of South Bend, Ind. These fixtures are of the bracket type, made up of pipe of straight or simple curvature, and wrought iron channel iron scrolls. These fixtures are shown in the accompanying illustrations.

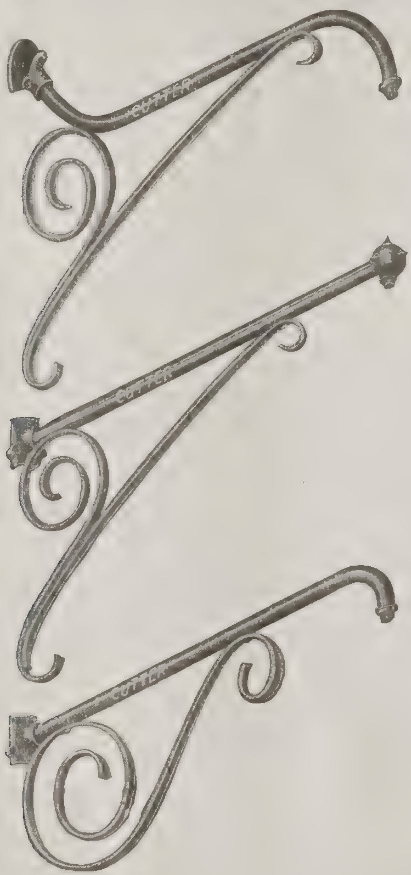


Fig. 1. Types of Cutter Street Lighting Brackets.

The brackets are made for inner or outer wiring, and with one-piece and two-piece fluted streethood bodies. Fig. 2 shows a one-piece body with a 24-inch radial bowl reflector and an Alba diffusing globe. The reflector is designed particularly for lamps of large sizes, either multiple or series. The globe protects the lamps from rain and sleet, which would tend to crack them on account of the high temperature of the bulbs, and also provides ventilation through the hole in the bottom where the air enters, circulates around the lamp and vertically through the top of the streethood porcelain, where it passes out through the arches around the lower edge of the canopy. This globe is also designed to shield the eye from glare produced by the high intrinsic brilliancy of the filament.

A cable clamp above the canopy holds the fixture to the span wire fastened to poles on either side of the street. Another method of keeping the fixtures level in stormy weather is shown in the diagram, Fig. 3, where an auxiliary cable attached to the streethood porcelain is fastened to the pole on one side of the street, both line wires running to insulators on the opposite pole. It is claimed that the high candle power lamps with this cable grip suspension fixture will be used largely for replacing arc lamps in the business districts of cities because of the simplicity, low first cost, high efficiency, and quality of light. The smaller sizes of lamps will find their largest field in lighting residence portions of cities, where brackets of artistic design will support the lamps beneath radial wave reflectors of 18, 20 and 24-inch diameters.

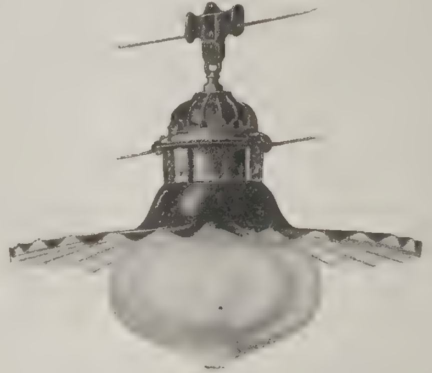


Fig. 2. One-Piece Body With Radial Bowl Reflector.

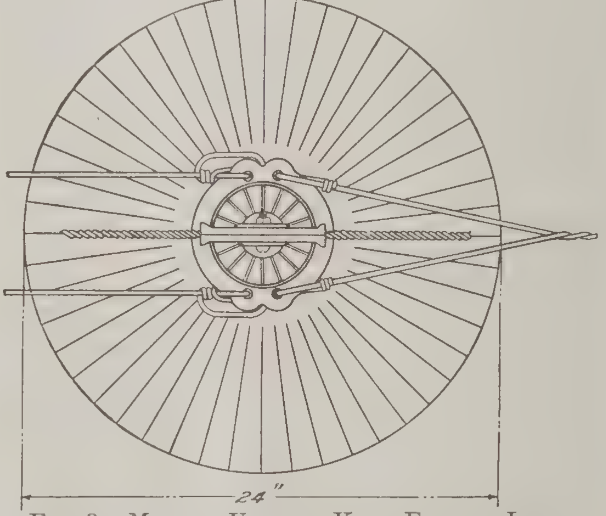
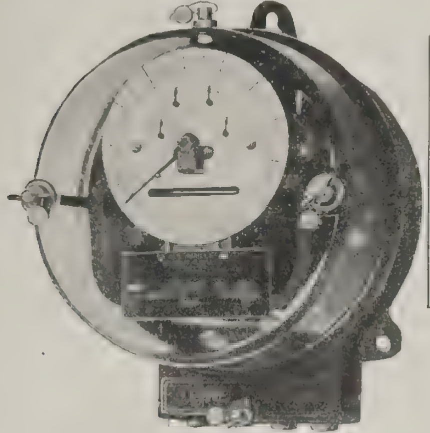


Fig. 3. Method Used to Keep Fixture Level.

Watthour Demand Meters.

A combination watthour and demand meter has been recently placed on the market by the Westinghouse Electric & Mfg. Co. It has been designed to meet a growing need on the part of central stations for a meter to determine by a simple reading the maximum demand of an installation. This is a single meter that records without the use of a clock mechanism both the kilowatt-hours consumed and the maximum kilowatt demand.

Because it fulfills both these purposes it is suitable for determining maximum demand and load factor as a basis for rates, as well as the diversity factor of the station.



A New Westinghouse Watthour Demand Meter.

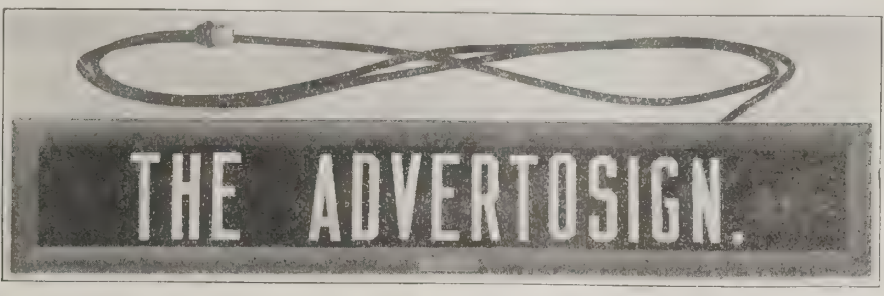
It provides precisely the readings needed on systems that base their charges on maximum demand and power delivered, both readings being taken monthly. The meter records the maximum demand of the connected load but not the time at which the maximum occurs. The maximum demand is indicated by a pointer sweeping over a 4-inch dial, and the watthour load is recorded on a 4-dial counter.

The meter is a combination of an induction watthour meter, an induction wattmeter, and an escapement form of time element. The instrument has a standard watthour meter movement, including electromagnet, permanent-magnet, and aluminum disk. In addition, it has an auxiliary disk sector supported on a jewel-and-ball bearing so that it can move in the air-gap of the electromagnet, in such a way that it does not interfere with the accuracy of the main disk, which always rotates at a speed proportional to the load. The rotation of the auxiliary disk is restrained by a spiral spring, making its final deflection proportional to the watts load. The auxiliary disk with its spring and pointer constitute an indicating wattmeter.

As the total deflection and the rate of deflection of the auxiliary disk vary in direct proportion, the time required to reach the maximum position when any constant load is passed through the instrument is a constant. For example, if a load of 500 watts is supplied to a 5-ampere, 100-volt meter with 15-minute time element, the demand mechanism will reach equilibrium at the 500 watt point in 15 minutes. If instead a load of 1,000 watts is applied to the meter, the demand mechanism will have to move twice as far, to the 1,000-watt point, to reach equilibrium; but the double load will move the watthour disk twice as fast, causing the escapement to allow the demand disk to move twice as fast, and it will cover the double arc in the same time. A mathematical analysis of the instrument shows that the deflection for any varying load that does not continue long enough for the instrument to reach equilibrium is equal to the average load during the interval.

The Advertosign.

A new form of electrical window display sign, known as The "Advertosign," is now being manufactured by The Advertosign Company, 738 Monadnock Block, Chicago, Ill. The essential features of this device are its adaptability to any line of business, and the claim that more reading matter can be used in the frame than with any similar sign of equal length. By means of a set of individual letters, numerals and characters, the reading matter in The "Advertosign" may be changed on short notice. Three sizes are made—namely, 32½, 42 and 48 inches in length. The Advertosign employs a mono-metallic thermostat, both ends of which are securely bolted, leaving the apparatus unaffected by vibration.



The Advertosign.

Electrical Construction News

This department is maintained for the contractor, dealer, manufacturer and consulting engineer.

FLORIDA.

ATLANTIC BEACH. The Atlantic Beach Hotel plans to make extensive improvements and to change its lighting system from direct to A. C. systems. An ornamental street lighting system of about one mile is to be installed and some 85 cottages lighted. H. M. Stanford is manager.

JACKSONVILLE. The Stribling Wave Power Co. has been incorporated with a capital stock of $10,000 for the purpose of developing water power from waves. S. L. Stribling is president and general manager.

TAMPA. The Tampa Electric Co. has increased its capital stock from $100,000 to $200,000. New equipment is to be installed in its steam plant.

GEORGIA.

BALL GROUND. The Amicola Marble Co. is said to have purchased a water power plant on the Otawah River at Gober Station. A plant will be developed at this point.

COLUMBUS. The Columbus Power Co. plans to install additional equipment in its Goat Rock plant, now developing 7,500 Kw. It is understood that a 5,000 Kw. unit is to be installed, as well as water wheel, switchboard equipment, etc. The Stone & Webster Engineering Corp., of Boston, Mass., has charge of the installation.

MOULTRIE. The city is planning a white way system of 100 posts. R. J. Corbett is chairman of the purchasing committee.

ST. MARY'S. The St. Mary's Ice & Light Co., has recently been incorporated and plans to install an electric light plant and ice factory.

SAVANNAH. It is understood that the Savannah Lighting Company is planning to remodel its power plant and substation. Additional equipment will be installed. The Schofield Engineering Co., of Philadelphia, Pa., are in charge.

KENTUCKY.

FULTON. The Public Service Company of Western, Ky., has been incorporated by J. H. Broughton, W. C. Morehead and H. L. Lowe. This company is a consolidation of the Fulton Electric Light, Heat & Power Co., of Fulton, Ky., and the Hickman Electric, Ice & Water Co., of Hickman, Ky.

MISSISSIPPI.

GREENVILLE. The Delta Light & Traction Co. has recently purchased the Delta Electric Light, Power & Mfg. Co., of Greenville, and will make improvements to the system it now operates. Frank Robertshaw, of Greenville, is president; Ralph Claggett is secretary and general manager.

MERIDIAN. An explosion of a Heine boiler in the plant of the Meridian Light and Railway Co. recently caused considerable damage. Repairs are being made.

VICKSBURG. The Vicksburg Light & Power Co. has received a new street lighting contract and will overhaul the street lighting system. 226 incandescent lamps of 60 and 80 candle power will be installed, and 31 ornamental posts. The work will begin at once. C. G. Johnson is manager.

NORTH CAROLINA.

GREENVILLE. The city is to install 600 Kw. generating apparatus, condensers and auxiliaries in their plant. W. M. Piatt is engineer at Durham, N. C.

MANCHESTER. The Little River Power Co., which is now rebuilding its hydro-electric plant, is to install 300 Kw. additional generating capacity and arrange to furnish energy to Fayetteville, N. C. Sellers & Ritcey are consulting engineers, of Stephens-Girard Bldg., Philadelphia, Pa.

SCOTLAND NECK. The electric light and power plant is to be enlarged at an expenditure of about $10,000.

WASHINGTON. The city is to remodel the mechanical and electrical features of its power plant and make improvements. H. C. Charles is superintendent.

SOUTH CAROLINA.

ALLENDALE. The city is to construct an electric light plant, water works and sewer system. Bonds to the extent of $65,000 have been issued. H. S. Jaubon Engineering Co., of Atlanta, Ga., is in charge of the work.

DENMARK. The Denmark Light & Power Co., has been incorporated with a capital of $10,000, by C. E. Campbell, T. M. Phifer and F. G. Tompkins, of Columbia, S. C.

McBEE. It is understood that the McBee Electric Co., is to erect an electric plant on Cedar Creek and install two miles of transmission line. M. A. McPherson is engineer.

PERSONALS.

MR. W. A. THOMAS, who for several years past has been commercial engineer in charge of all sales of mining apparatus for the Westinghouse Electric & Mfg. Company with headquarters at East Pittsburgh, resigned his position with this company on June 1st, and has taken up the practice of consulting engineering in Pittsburgh wit hoffices in the Second National Bank building. Mr. Thomas is president of the Rocky Ridge Coal Company, of Robertsdale, Pa., which is an important bituminous coal mining company. His training in practical mining work, coupled with his work with the large electrical companies and extensive experience with mining companies, should peculiarly fit him for the new work which he has chosen.

HAROLD ALMERT, consulting engineer, Chicago, Ill., has been retained as technical counsel by the Washington Railway & Electric Company and the Potomac Electric Power Company, of Washington, D. C. The appraisal division of Mr. Almert's staff will make a detailed inventory and valuation of the property of these companies, not only in Washington, but throughout the District of Columbia, in preparation for a hearing before the Federal Utility Commission, which Commission appeared before the local committee of congress on June 2nd, through the corporation counsel, and declared itself in favor of immediate federal ownership of the utilities in the District of Columbia.

WM. A. BOLE has been elected vice president of the Westinghouse Machine Company in charge of production and erection for the plants at East Pittsburgh and at Trafford. Mr. Bole has been in the continuous employ of the company since August, 1882, having successively filled the positions of general shop foreman, superintendent, manager of works and consulting engineer, and has therefore taken part in the growth and development of the company since it employed less than 100 men until the present when the total forces run up into the thousands of **operatives.**

Electrical Testing Laboratories

Photometrical Department.

Photometrical tests of all forms of commercial illuminants. Illumination tests made anywhere indoors or outdoors.

Electrical Department.

Tests of electrical instruments, apparatus and materials. Inspection of electrical material and apparatus at factories.

General Testing Department.

Coal and ash analyzed. Paper tested. Industrial and clinical thermometers checked. Tensile, compression and torsion tests of structural materials. Complete tests on cement and concrete.

80th Street and East End Avenue
NEW YORK, N. Y.

MR. J. E. MAIR, sales engineer for the Appleton Electric Company, Chicago, Ill., who has recently made a business trip throughout the South for his company and is now on his way back to Cheiago, reports an optimistic feeling among Southern jobbers and electrical contractors. Mr. Mair says that business throughout Texas is good and judging from the nature of orders taken among jobbers in other Southern states, indications are that electrical construction is going ahead in spite of much talked of hinderences due to poor business conditions in the North. Mr. Mair made a similar trip last year at about this time and reports a favorable increase in actual business for his company. In fact the Appleton products are so favorably received in certain sections that it is probable that a branch office will be established in Atlanta at an early date. We hope this expansion of the company will bring Mr. Mair to this section permanently as he is a past master in making friends and generally liked in a personal and business way.

What to Buy and Why---Told in Catalogues Just Issued

The following catalogs have just been published by the companies named and can be secured without charge by writing to the addresses given. Many of these catalogs contain data you will value.

Bulletin No.	Name.	Company.
680-1	Steel Tape Armored Cable	Standard Underground Cable Co., Philadelphia, Pa.
117	D. C. Factory Sewing Machine Motors	Robbins & Myers Co., Springfield, Ohio.
—	Western Electric Interphones	Western Electric Co., New York City.
21	Panel Boards & Switches	Frank Adams Electric Co., St. Louis, Mo.
7	Textile Quarterly	Westinghouse Elec. & Mfg. Co., East Pittsburg, Pa.
DS845	Porcelain & Glass Insulators	Westinghouse Elec. & Mfg. Co., East Pittsburg, Pa.
8	Westinghouse Railway Data Exchange	Westinghouse Elec. & Mfg. Co., East Pittsburg, Pa.
1531-5-14	Wicker-Type Electric Linotype Pots	Westinghouse Elec. & Mfg. Co., East Pittsburg, Pa.
13	Steel Tower Substations with Jib Cranes and Transfer Table. Also data on Installation	Delta Star Electric Co., Chicago, Ill.
—	Data on Mica for Insulation purposes	Meirowsky Bros., Jersey City, N. J.
100	National Metal Molding and Fittings	National Metal Molding Co., Pittsburgh, Pa.
—	Facts regarding Electric Window Signs	Advertosign Co., Chicago, Ill.
—	Pull Sockets	W. R. Ostrander and Co., 22 Dey St., New York City.
—	New Wire Reel	Wiring Equipment Co., 30 Church St., New York City.
—	Data on Chain Drives, the first of the kind yet published.	Link Belt Company, Chicago, Ill.

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The Opportunity of the Year for Southern Central Stations.

In a little more than two weeks after this issue of *Electrical Engineering* reaches its readers, a convention of the Southeastern Section of the National Electric Light Association, the first to be held outside the state of Georgia, will be in session at the Isle of Palms, near Charleston, S. C. This convention is now one of the important events of the year among southern central stations, a fact that is readily recognized from the usual attendance made up not only of managers and new business men, but engineers and operators, men who are familiar with the engineering details of construction and operation and men who are sent to this convention by their managements to tell what they may know, when by so doing any good will be derived by those who attend as listeners. The sessions of the convention of this section are known as working sessions and proudly maintained as such by those responsible for the program and carrying it out.

The Isle of Palms is an appropriate meeting place for this convention on account of being generally known as the "Atlantic City of the South," with special railroad rates in effect from all important points and further due to its proximity to a section of the South where electrical development of all industries has reached a stage not only interesting to members of the Southeastern Section but to central station men in all parts of the country who have to do with the generation of electrical energy from water power and its transmission at high voltages over considerable distances.

Early in the spring of this year, the various committees in charge of the convention arrangements began active work and now have arranged all details essential to a successful convention, so that those who have reason to know predict that the coming meeting is to be one of the milestones in southern central station progress. The moving spirit in all the work that has been done is President T. W. Peters, of Columbus (Ga.), his energy and enthusiasm cropping out in all the plans that have thus far been made known. This is, however, to be expected of the section president this year, for probably no other man has been so continuously and intimately identified with association work in the South since the formation of the Georgia section in 1910, acting as secretary and treasurer of that section during the first year of its existence, then as chairman of various committees, and later as an organizer and vice-president of the Southeastern Section during its first year. His intimate knowledge of association affairs in the South has thus made his work during the past year of decided value in placing the section on its present firm footing.

In the July issue of *Electrical Engineering,* and on page 337 of this number, convention details are outlined. In regard to same President Peters has the following to say: "I believe that the paper which Mr. J. S. Bleecker will present on 'How, When and Where, which gives a few thoughts on regulation and the report of the public policy committee to be presented by Mr. P. S. Arkwright, president of the Georgia Railway and Power Company, will be well worth the time and money spent by any company in making it possible for a representative to attend the convention. Another feature that will be worth while is what will be known as an 'experience meeting.' During this meeting, for which about one-half of a session will be given over, a discussion of any subject may be taken up by any member or guest."

The entertainment features have been carefully planned and will include a trip by boat to the different points of interest about Charleston, including the Navy Yard and Fort Sumpter. An automobile trip and a smoker are also planned. It is thus apparent that one feature only is now wanting to make this convention the best ever held in the Southeast. This feature is attendance, so let every one come who can!

Formula for Success.

The attainment of success is the goal of every normal man's endeavor. The discovery of the laws govering success has been the quest of large and small minds, the strong and the weak since the beginning of time, yet today the formula remains essentially empirical, the best results from same being secured when the user has an extensive practical knowledge of all the factors and conditions under which he works. Perhaps one of the best of these empirical formulas has been worded by Bishop Spaulding as follows:

"Success lies in never tiring of doing; in repeating and never ceasing to repeat; in toiling; in hearing and observing; in watching and experimenting; in falling back on oneself by reflection, turning the thought over and over, round and about the mind and vision, acting upon it again and again—this is the law of growth. The secret is to do, to do it now, and not look away at all."

To men employed in the different departments of public utility companies, the disposition above described is indeed paramount, because the all-important question is rendering satisfactory service to the consumer. If this rule be generally observed and especially so in emergencies, without regard to the clock, the welfare of the company will then be assured, and to the man will come success.

It should always be remembered that long service alone has never gained for any man promotion to a better paying position, for in filling vacancies a company usually seeks the most capable man with the idea of approaching as closely as possible ideal standards of management and operation. It is important, therefore, that every man should show an earnestness in all his efforts to fit himself for a higher position, since the advance to new duties and better pay go hand in hand. The reason why some men receive higher wages than others was appropriately phrased by Elbert Hubbard when he said, "Every employe pays for superintendence and inspection. Some pay more and some less. That is to say, a dollar-a-day man would receive two dollars a day were it not for the fact that some one has to think for him, look after him, and supply the will that holds him to his task. Make no mistake about this; incompetence and disinclination require supervision, and you pay for it; no one else does. Do your work so well that it will require no supervision, and by doing your own thinking, you will save the expense of hiring some one to think for you."

As no man can know everything about his work, he should never, even at times of certain progress, let his pride get the best of him, but should value opinions of, and consult with others. Officers of public service companies are always willing and ready to answer questions and assist in the promotion of a knowledge of their business and favor such a spirit in employes when the ambition to advance is shown. *Electrical Engineering* offers an opportunity to every reader to make known to others such a spirit of co-operation, by maintaining a department for discussing and solving any problems that may prove puzzling, with no charge attached to any use of its columns. Besides keeping abreast of the times by reading about, and watching the advancement of the allied industries, it is important that one keep well posted as to the doings of the company, if for no other reason, as a matter of public policy. To those that have reliable information based on practice or experience the following advice should make it plain that submitting such data for publication and general discussion will always prove of considerable mutual value.

Don't be afraid to impart to others what you know, when it is something that may help them without hurting you. Pointers that are kept to one's self get rusty like the gold-pieces that a miser stows away in a dark crevice. Gold was brought into the honest daylight and minted for the express purpose that it should circulate for the benefit of all—and the same is true about the facts that men dig from the mines of experience."

M. William Ehrlich.

Westinghouse Strike Ended.

On July 9th, the employes of the Westinghouse Electric and Manufacturing Company, of East Pittsburgh, Pa., called off a strike that had caused them to be out of work for about a month. The date set for return to work was Monday, July 13, however, a large number of men reported on Friday and Saturday, the 10th and 11th. All departments of the plant are now operating on full time. The attitude of the company during this strike and the publication of the company's policy in newspapers making plain a desire to always give employes a square deal, was largely responsible for the return of the workers.

One Company to Supply Paris With Light and Power.

During the present year the distribution of electricity for lighting and power purposes in Paris passes into the hands of one company which will have a monopoly until 1940. There is a clause in the contract made with the municipal administration which requires the company to furnish current for lighting purposes at 50 centimes (9.65 cents) per kilowatt hour at 30 centimes (5.79 cents) per kilowatt hour for power, heat, or other purposes. The company, which is capitalized at 100,000,000 francs ($19,300,-000), is called the Compagnie Parisienne de Distribution d' Electricite, with head offices at 23 Rue de Vienne. Five of the companies which formerly supplied the city with electric current will liquidate, while the other two will operate in the suburbs of the city, La Societe d'Eclairage et de Force par Electricite in the north suburban district, and La Compagnie Electrique du Secteur de la Rive Gauche in the eastern, southern, and western suburban districts.

The Keokuk to St. Louis Transmission Line and Substation Details at St. Louis

BY JOHN D. EDWARDS, CONSULTING ENGINEER, ST. LOUIS, MO.

THE transmission line used between the Mississippi River Power Company's new station at Keokuk, Iowa, and St. Louis to transmit energy to the latter city is unique in many ways. It is the longest transmission line to handle such a large block of power (60,000 Kw.) and further has the greates number of long river span crossings of any line. The right of way commences in the state of Illinois directly opposite the power station at Keokuk, Iowa, and runs directly south in a straight line, with the exception of two jogs, to a point about seven miles south of Quincy, Ill., where it turns and runs in a southeasterly direction to a point in Illinois on the Mississippi River about 50 miles up from St. Louis. Here the line crosses to Missouri and spans the point of land formed by the Mississippi and Missouri Rivers in Missouri to the Missouri side, and crosses into St. Louis County. It then heads directly, with the exception of one right angle turn, to the receiving station at the western city limit of St. Louis. The right of way is 100 feet wide the entire distance of 146 miles. The line crosses the Mississippi River twice and the Missouri River once.

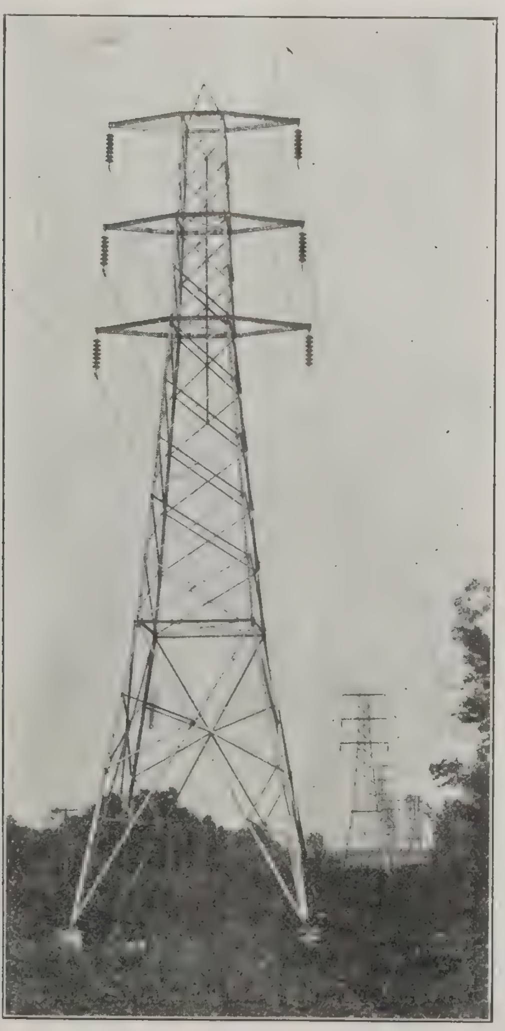


FIG. 1. TYPE OF LINE TOWER USED BETWEEN KEOKUK AND ST. LOUIS.

TRANSMISSION LINE TOWERS.

At present there is one line of steel towers which has been installed on one side of the right of way, room being left for an additional future line. The foundation of towers varies according to size and location of same relative to strains. At river crossings these foundations, which are four per tower, are 3 feet, 3 inches square. For anchor towers a special heavy concrete substructure is used. At turns in the line a foundation is made by pouring the concrete into circular forms 21 inches in diameter and sunk in the ground at depths varying with the nature of the soil. These forms are made of No. 14 sheet steel riveted. On the straight line the foundations are the same as those mentioned only the steel forms are 12 inches in diameter. These steel forms were put in the holes excavated for the tower foundation and left in place after concrete was poured around foundation bolts. Trees on the right of way were cut down and even the branches on trees bordering on the right of way cut off if they projected over.

The towers are all of heavily galvanized steel angles and channels riveted and bolted together. On the straight line towers there are three cross arms each made of two 10-inch channel irons back to back, one on each side of tower and projecting equally both ways. These arms are of such a length that the wires are held 24 feet apart horizontally on a straight line. The spacing of the arms vertically is such that the three conductors of each circuit are held 10 feet apart.

Towers used as anchors at the Missouri River crossing have each of the four legs made of two 4-inch x 6-inch x 8-inch angles and correspondingly heavy braces laterally. The feet of these are on 24 foot centers. These towers only carry three conductors in a horizontal plane, one being in the center of the tower and the other 20 feet each side. They have four 2-inch holding down bolts for each leg, and are 80 feet high, which give the lowest conductor a 50-foot clearance from the ground with the spacing employed. These anchor towers are shown in Figs. 2 and 3.

The towers used to give proper clearance to the wires at the Missouri River crossing are 220 feet high on the south side of the river and 50 feet high on the north side. The foundations for these are 36 feet, 9 inches center to center. These towers are of the proper height to hold the transmission wires at such a distance above high water as to comply with Government regulations. There is only one cross arm on these towers which holds the three conductors in the horizontal plane. The towers are of the Riter-Conley type.

LINE INSULATORS.

The insulators used on the transmission line are of the Ohio Brass Co., type, 10 inches in diameter and 8 sections per unit. They were subjected to a wet test of 330,000 volts, thus giving a safety factor of 1 : 3. Each one of these insulator units is almost 4 feet long.

At the Missouri River crossing, the span, which is about 3,000 feet, is held by 48 discs per conductor or 6 units of 8 insulator discs per unit. These crossing insulators are held by an equalizing bar arrangement which puts the same strain on each of the six units. This combination has a tensile strength of 60,000 pounds.

At anchor towers, which are about every 7,000 feet along the line, the conductors are dead ended to the towers by two units per conductor. On the straight line sections the insulators hang directly down from the ends of arms, thus giving a flexible swinging connection.

There are at present two, three-wire circuits supported by these towers which are each composed of 300,000 c.m. 16 strand copper cable $\frac{5}{8}$ inch outside diameter. The corona point for these conductors is 148,000 volts which is about 48,000 above that used on the line. The ultimate tensile strength of this conductor is 14,000 pounds, which gives a good safety factor even under such severe conditions as zero degrees Fahrenheit, with a $\frac{1}{2}$-inch ice coating and a 60 mile an hour wind. It might be well in passing to note that such a weather condition as this has never been experienced by the writer in this part of the country, since when a sleet storm occurs in this portion of the Mississippi Valley the weather is usually but little below freezing temperature and there is seldom any wind.

The clamps used to tie the conductors to the insulators have the shape of an equilateral triangle 12 inches on a side and made of $\frac{1}{2}$-inch sheet steel. One corner of this clamp has a bolt which, with the two sides of the clamp form a clevis for the connection to the insulator. The groove through this clamp is corrugated and also flared at the ends so that the conductor does not have to pass immediately from a rigid support to the span, thus to a certain extent avoiding the tendency to crystalize.

At the Missouri River crossing the conductors are made with a $\frac{5}{8}$-inch steel core with an outside layer of copper strands, making the overall diameter $\frac{7}{8}$ inch.

GROUND WIRES.

The ground wires are of $\frac{5}{8}$-in. standard Siemens-Martin steel having an ultimate tensile strength of 11,000 lbs. The most severe weather conditions are not expected to exert a pull of over 5,000 to 6,000 lbs. This wire is grounded at every tenth pole. It might be well to add here that the river crossing towers are grounded by having a $2\frac{1}{2}$-in. x $2\frac{1}{2}$-in. x $\frac{1}{4}$-in. angle iron driven near each leg and a $\frac{3}{8}$-in. galvanized stranded steel wire connected from the tower leg to it.

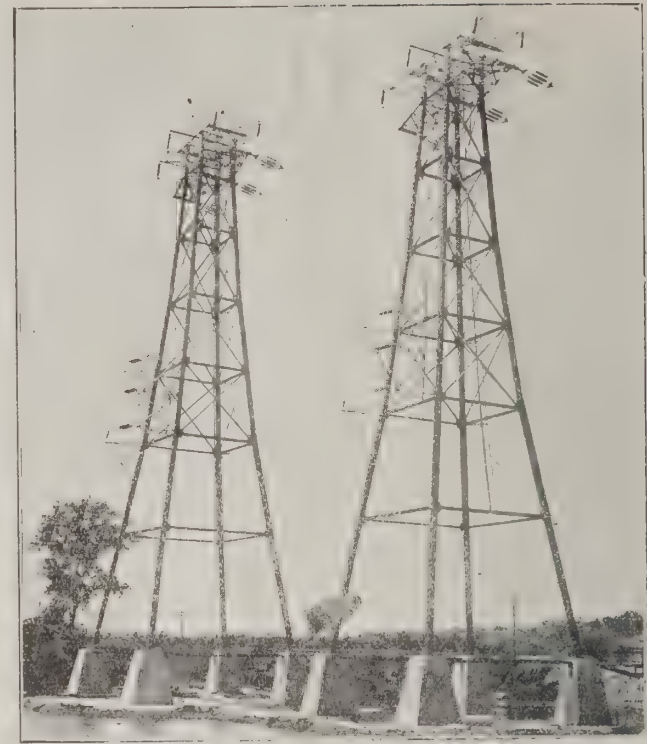


Fig. 2. Towers at Missouri River Crossing—South Side—220 Feet High for Clearance.

TELEPHONE LINE.

A telephone line of 30-foot cedar poles has been constructed along one side of the right of way carrying 4-pin cross arms. The telephone circuit is composed of two No. 8 copper wires supported on porcelain insulators. The telephone booths, which are located every three or four miles, are of wood 4 x 4 x 8 feet high. Where the two wires

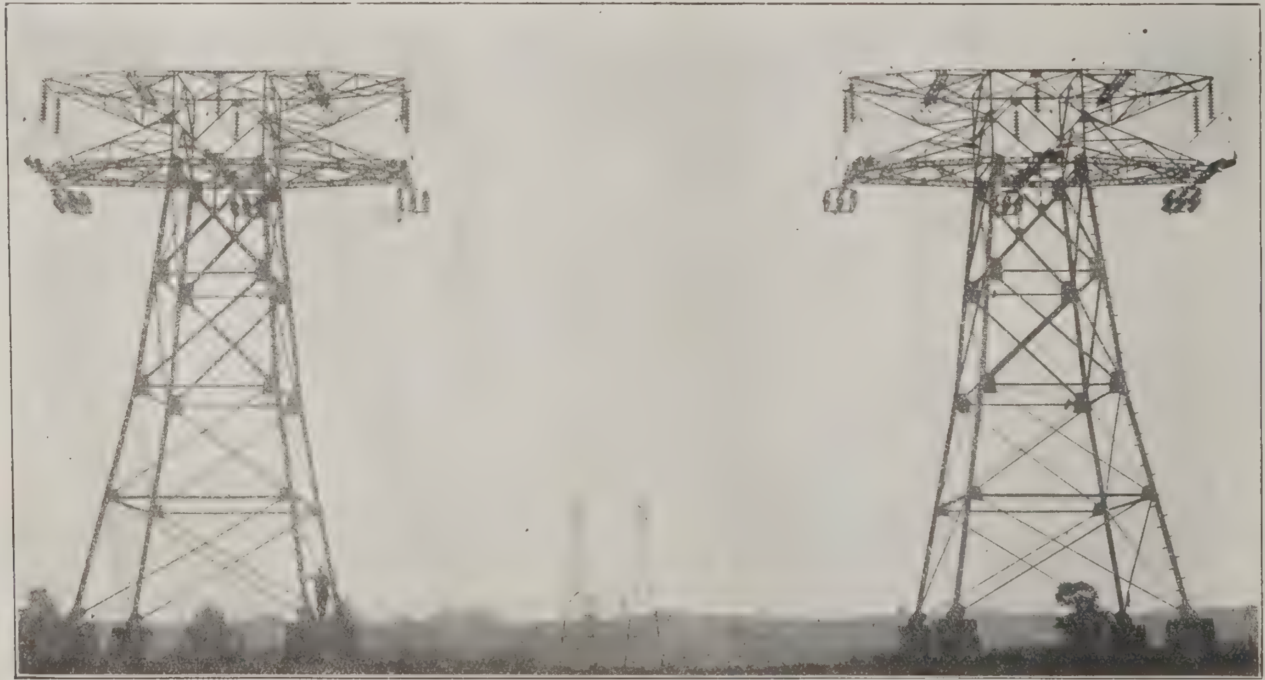


Fig. 3. 50-Foot Anchor Towers at Missouri River Crossing—North Side—With Clearance Towers in Background.

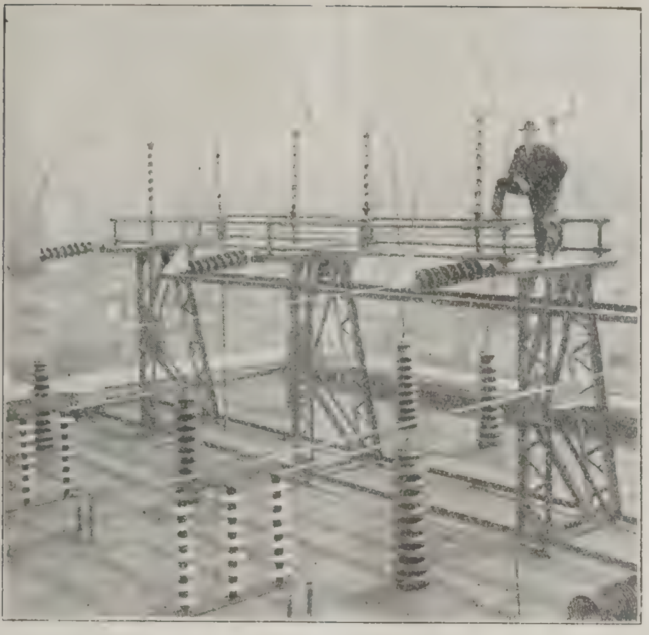


FIG. 4. ARRANGEMENTS FOR ROOF ENTRANCE OF LINE AT ST. LOUIS SUBSTATION.

pass through the wall of the booth, bushings of 6,600 volt style are used.

It might be mentioned that since the transmission has been in operation, or since July 1st of last year, while there have been several storms which have interfered with the 13,000-volt secondary distribution in St. Louis more or less, there has not been any failure on the 100,000-volt line from Keokuk. It may be of interest also to say that since the line was first placed in operation 64,000 Kw. have been transmitted from Keokuk to St. Louis without any trouble of any kind. The voltage at the receiving substation in St. Louis averages about 96,000 volts.

PAGE AVENUE SUBSTATION AT ST. LOUIS.

The Page Avenue station at St. Louis receives and transforms the energy transmitted to St. Louis from the water power station located on the Mississippi river at Keokuk, Iowa, for local distribution. The property on which the station is located is just west of St. Louis western city limit and at the end of the right of way from Keokuk. At the north end of the tract one of the belt lines of the St. Louis Terminal Railway runs so that the station thus has unequaled facilities for receiving shipments of material etc. A track connects with the above mentioned railroad and runs through the property and alongside the station, passing under an extension of a crane runway, thus permitting machinery and material to be unloaded expeditously.

Near the north end of the tract is located a concrete basin 200 feet long by 64 feet wide by 12 feet deep. This basin is divided into two equal parts lengthwise by a brick wall, and holds the water used to cool the large step down transformers and other transformers in the station. This water is cooled by exposure to the air.

The building is in the ground plan shaped like the letter T with an extreme overall length of 226 feet and a width of 125 feet at the wide part of the T. The building foundations are of concrete, with walls of red pressed brick. On the west side of the building are 12 doorways 14 feet wide, three doorways to each transformer compartment, closed by Kinnear rolling steel doors. These doorways are for the placing of the large transformers.

The floors throughout the building are of concrete supported by I beams and are of such thickness that all conduit used for control wiring, lighting etc., is imbedded in it. The basement, which extends under the entire building, is divided into a number of rooms which contain transformer oil tanks, bus bar structures etc. The office of the superintendent is located on the balcony on the east side of the building. Here is located a private branch exchange switchboard for the telephone service around the station. On the main floor on the east side is located a room for the operating force, containing steel lockers, a shower bath, etc.

The station lighting is controlled by three panel boards set into steel boxes in the wall. One of these panel boards is located on the balcony near the office, another directly below on the main floor, and the third one in the basement. The lighting fixtures are shown in Fig. 5.

The station has no heating facilities as it is expected that the heat due to the I^2R loss in apparatus will keep the station fairly warm and besides the climate in St. Louis is never severe.

INCOMING TRANSMISSION LINE.

The two three wire, three-phase transmission lines from Keokuk tap onto two additional lines about a mile from the station thus making a double steel tower line the last mile carrying 12 conductors, or 4 three-wire circuits. The reason for building this extra line was due to the railroad crossings. The tower line strikes the building on the west side, and the last two towers are staggered so that the four lines run directly to their dead end insulator strings on a steel frame structure on the roof of the building. The loops around the insulators are made of galvanized iron pipe which hold shape better than the conductor itself would The above mentioned steel frame, besides acting as a dead end for the transmission wires, also supports porcelain pillar insulators to hold motor operated disconnecting switches. The conductor next runs to the line side of horn gaps as shown in Fig. 4. A tap is taken off between the two structures which runs through two choke coils in series down to the oil switches shown more in detail in Fig. 4. From the choke coils, a pipe connection runs directly over to the line side of the horn gaps. The other side of the gaps

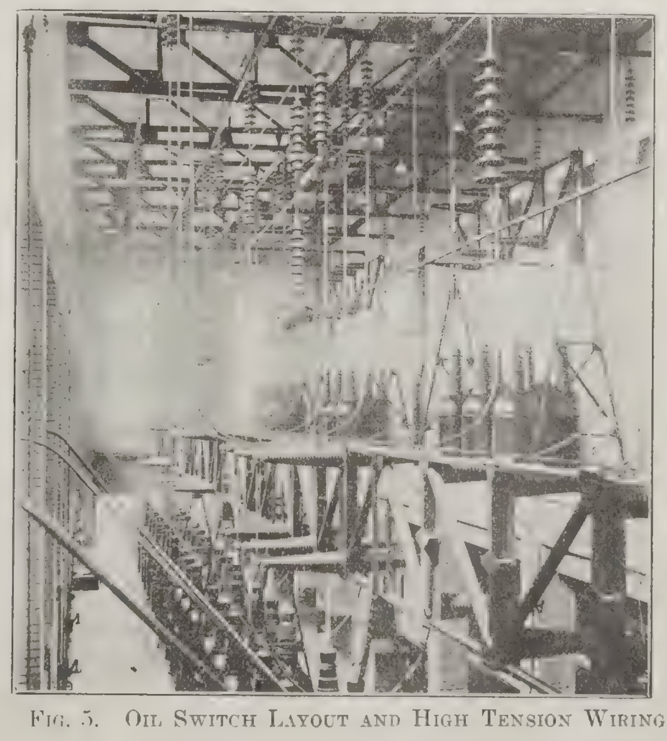


FIG. 5. OIL SWITCH LAYOUT AND HIGH TENSION WIRING.

connects to a roof bushing and down to the arresters. This arrangement is shown in Fig. 4. The horn gaps are set at 8 inches. From the above it is seen that each of the four transmission lines has six roof bushings, three to the oil switches and three to the lightning arresters.

HANDLING HIGH TENSION LINES IN BUILDING.

Standing at the north end of the station and looking south through it, the second floor or balcony on the left or east side holds the aluminum cell lightning arresters. These are mounted in boiler steel plate tanks, which stand near the east windows. On the same floor near the center of the building are the line oil switches, four in number, shown in Fig. 5. These switches are of the General Electric K-15 single pole type, and are rated at 400 amp. and 110,000 volts, solenoid operated. The closing and opening solenoids stand on the floor and are mechanically interlocked to insure simultaneous operation of the three units. The 110,000 bus consists of copper tubing suspended in the open air by insulators hung from the roof of the station. The insulators are of the suspension type similar to those used on the transmission line. The bus runs lengthways of the station and is divided into four sections which are tied together through oil switches of the same type and capacity as those mentioned above. Connected to each of the four sections mentioned above is a similar oil switch used to cut the energy on and off of the large transformer banks.

The disconnecting switches of Fig. 5, used with the above mentioned oil switches are worthy of note. They consist of two brass heads mounted on porcelain pillars, the two pillars being supported on a steel plate. Through one of these heads and into the other slides a brass rod with an eye at the lower end. This eye is of the proper size to receive the hook at the end of the disconnecting rod used to close and open it. These switches are closed by a vertical push on the rod and opened by a pull on same.

The west side of the building is used to house the transformers and is separated from the rest of the station by a brick wall which runs up to within about ten feet of the ceiling. The pilasters extend on up to the ceiling, thus openings are left which are approximately square and thru which pass the connections from the oil switches to the transformers. These connections consist of 2-inch galvanized iron pipe as shown in Fig. 5 which run straight through the above mentioned openings from the oil switches to the terminals on the tops of the transformers. This pipe was used because it would hold its shape with fewer supports than any other conductor.

TRANSFORMERS.

The four banks of step down transformers each consist of three single-phase units of 5,000 Kva. capacity each, with a ratio of 95,000/13,800 volts. These transformers are of General Electric make, oil insulated and water cooled. The cooling water pipes come up from the basement on the opposite side of the wall (that is in the main part of the building). Valves and glass aperture fittings are located in the pipes at convenient heights for the operators on the main floor. The cooling water is circulated through these pipes from the reservoir mentioned above by two 5-in. discharge two stage Alberger turbine pumps running at 1,500 r. p. m. and delivering water at 90 pounds pressure. These pumps are run by a 50 Hp., 25 cycle, 220-volt, induction motor direct connected to the pump shaft. The intake and discharge for this cooling system comes into the station through pipes from the reservoir mentioned earlier in this article. These pipes run under ground. Unions in the pipes near the transformers allow the latter to be disconnected when it is necessary to move them.

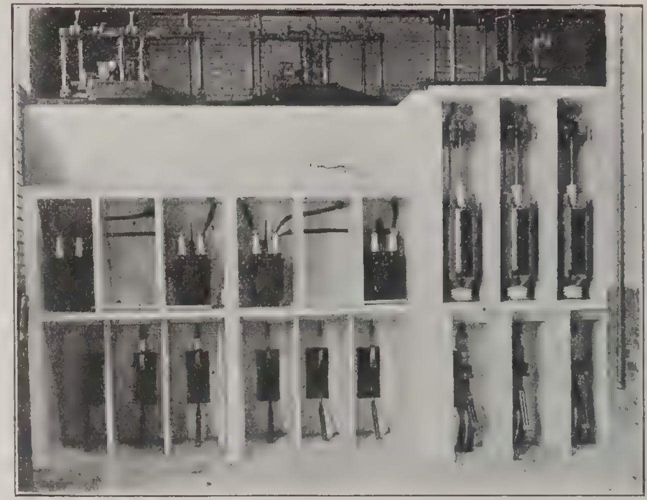


Fig. 6. Switches Controlling Railway Feeders.

Whenever it is desired to empty the transformers of oil for repairs or inspection there is a cylindrical steel tank of 40,000 gallons in a compartment in the basement directly under them. These tanks, of which there are four, are similar to those used on tank cars.

The high and low tension leads enter the top of the transformer case through porcelain bushings. The transformers are connected in delta.

HANDLING LOW TENSION.

The secondaries of the above transformers are run down beside their respective cases through concrete columns into ducts in the floor through which they run to a concrete structure formed of barriers and shelves holding the current and potential transformers used for the relays and recording instruments. From these the leads go into the main 13,800 volt station buses. The 13,800 volt bus runs the length of the basement, which is under the high tension part of the building, and consists of 3 x ¼ inch copper bar, supported on corrugated porcelain pillar type insulators. The barriers and dividing wall in this structure are concrete. The structure is held about 4 feet, 4 inches clear of the floor by 10 x 12-inch concrete columns spaced 5 feet apart. The bus is in two parts, one on each side of the structure.

On the main floor directly above the 13,800 volt bus is a row of General Electric type H6 oil switches mounted in concrete cells shown in Fig. 6. These switches control the different feeders running out from this station for railway, light and power.

LIGHT COMPANY'S APPARATUS.

Current is taken from the 13,800 volt bus by the H6 switches mentioned above and fed into a bank of Westinghouse transformers which are oil insulated and water cooled and which step down from 13,800 to 6,900 volts. The current is lead at this voltage to the necessary oil switches, current and potential transformers and starting compensators to the frequency changers, only one of which is at present installed. This set consists of a General Electric motor-generator, the motor of which is rated at 8,900 Hp. at 300 r. p. m. and is wound for 6,600 volts, 25-cycle, 3-phase current. This machine is direct connected to a 5,000 Kw. 4400/2500 volt 60 cycle generator. This 4400 volt current is delivered to the bus which is located in a structure on the main floor, which structure also holds the oil switches used to control the 60 cycle circuits. These switches are

General Electric K-12 and are solenoid operated from a control switchboard directly above on the balcony, as shown in background of Fig. 7.

Current is taken from this bus and stepped to 13,800 volts by a bank of Westinghouse transformers, at which voltage it is transmitted to the main steam station of the local company which is known as the Ashley St. station and is located about 7 miles east of this station on the Mississippi river.

RAILWAY PART OF THE STATION.

The United Railways Co. of St. Louis which is under contract to take 25,000 Kw. of this energy, converts 4000 Kw. into 600 volt direct current at this point. The energy for this sub-station is taken fro mthe main station bus through oil switches and cables to the oil switches which stand near the rotaries, of which there are two. The oil switches used to control this energy are the General Electric H6 design, the same as those located on the main bus and shown in Fig. 6. These switches connect the bus which is in a chamber below the floor to the step down transformers for the rotaries. These units are General Electric 2200 Kva., 3-phase, 13,800 to 430 volts, and air cooled by two blower sets which stand on the main floor not far from them. It might be well to note in passing that these transformers are so constructed that the laminations are on the outside with no casing over them but directly exposed to the air. The cores have slots through which the air passes from the inside air ducts. There is one of these transformer units to each rotary converter.

The rotaries are of 2,000 Kw. each, the A. C. end being 430 volt, 6-phase and 600 volt on the D. C. end. The switchboard for these rotaries is of General Electric design for railway use with panels for the control of the 13,800 volt current and D. C. rotary and feeder panels. The ammeters on the feeder panels of this board are of the horizontal edgewise type. There is a panel in this board to meter the total output of the rotaries, the meter used being a Sangamo shunt type. The shunt used for this meter is of 20,000 ampere capacity.

The main switchboard that controls the transmission lines, buses, and transformers, stands on the second floor balcony and from it the operators are afforded a clear view of the high tension end of the station. On the sub-base of line panels are three inverse current relays which come into action should the transmission line lose power from Keokuk and prevent the steam driven station in St. Louis from feeding back or the other transmission line from doing the same thing should one line become disabled. This is an extremely important feature as should a line become disabled the absence of the above relays would quite likely put the whole transmission system out of commission. Besides the four transmission line panels the bench board also controls the feeders running to the Union Electric and United Railways companies stations

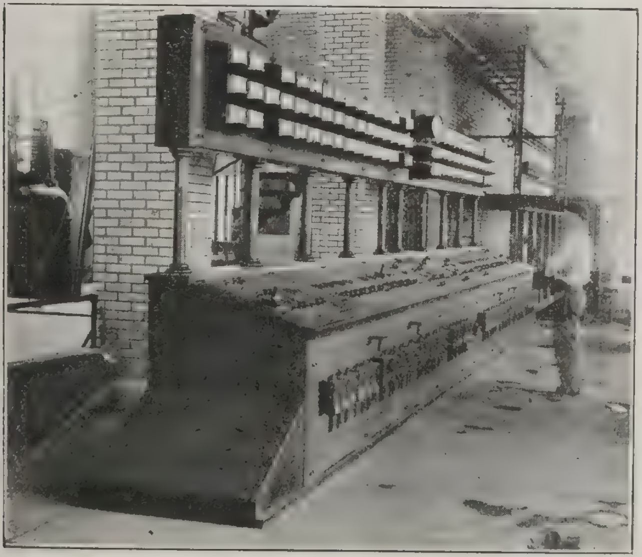


FIG. 7. CONTROL BOARD AT ST. LOUIS SUBSTATION.

In a room off the balcony is located a 35 amp. hour storage battery which is used to energize the control busses on the bench board. This battery is charged from a set consisting of a 15 Hp. 220-volt, 25 cycle motor direct connected to an 8 Kw. 125-volt generator. Another auxiliary located in the basement is an air compressor made by Ingersoll Rand with 8 x 8 inch cylinders which delivers air at 100 lbs. pressure to a 36 x 72 inch tank. This compressor is belted to a 25 Hp., 220-volt, 25 cycle motor. This air is used to clean out apparatus and is piped all over the building. It might be of interest to note that when the air piping goes from one floor to another the iron pipe railings on the stairs are used with hose connections on the newel posts.

Inspection of Generating and Substations of Georgia Railway and Power Company by Georgia Municipal Officials.

A modern philosopher has said that the badge of sanity among business men is a willingness to get together and solve mutual problems jointly. On Friday and Saturday, June 26th and 27th, such a feeling was decidedly noticeable when some 50 Georgia mayors, chairmen of water and light commissions, and superintendents of plants representing 19 different Georgia towns, came to Atlanta for the purpose of learning something of the technical and commercial details of the supply of light and power by one of the newest and one of the largest hydro-electric generating and power transmission companies of the South, the Georgia Railway and Power Company.

A special program of addresses and instructive papers had been prepared on operating conditions and commercial arrangements and through these many details new to those in attendance were taken up and discussed. This session occupied the entire forenoon on Friday. During the remainder of the time the Atlanta steam plants, two in number, the Alabama Street substation, the engineering and meter departments, and the Boulevard high tension substation were visited. On Saturday a trip was also made by automobile to the Bull Sluice hydro-electric plant some ten miles from Atlanta, and here a barbecue was held.

The meeting was planned and carried out in such a way as to enable those who are and those who contemplate using the company's service to become familiar with any details either technical or commercial that are of interest, and as such the meeting was a great success. Engineers, city executives and councilmen went away with definite information that will enable them to better handle their own electrical problems and besides have a fairly good idea of the workings of a large generating and transmission system such as that of the Georgia Railway and Power Company, a system that is attracting attention and bringing new business to every city and town of the section through which its lines pass and a system of which the entire South should be proud.

The Selection, Care and Operation of Carbon Brushes

BY E. H. MARTINDALE, E. E., MEMBER A. I. E. E.

Section 4. Precautions When Installing and Testing Brushes.

WHEN a set of carbon brushes is to be installed on a motor or generator, the time spent in thoroughly overhauling the entire equipment in order to give the brushes a chance to work properly, will be amply repaid. If a change in the grade of the brush is made with the intention of testing the new grade, it is essential that a complete set of the new brushes be installed. The difference in specific resistance, contact drop, coefficient of friction, abrasiveness and other characteristics of two grades of carbon brushes on the same machine may cause such an unequal distribution of load that the better brushes will appear to be the poorer grade.

The writer at one time was following a test of brushes conducted on a United States Light & Heating Company's axle car lighting generator as used on electric lighted Pullman cars. There were four brushes on each machine and twelve brushes were submitted for test. As they were furnished by the brush manufacturer without holes drilled for attachment of the pigtails, they were sent to the machine shop for such drilling. The first two sets tested gave excellent results in every respect, but the third set tested on the same machine operated very poorly. All four of the brushes picked up copper which became imbedded in the brush faces and reduced the contact drop to such a value that high short circuit currents developed under the brush faces and caused excessive sparking.

This case was a puzzling one until a careful examination of the four brushes disclosed one brush of a different grade. The twelve brushes submitted for the test were not copper coated and had the grade plainly marked on them. One brush of the last four tested had no marks and had apparently been copper coated as copper could be found in some of the minute holes which are frequently found in the poorer grades of brushes. The odd brush was lighter in color, softer and contained more graphite than the other brushes. Investigation showed that the workman who was given the task of drilling the brushes had broken one of them and had peeled the copper from another brush, drilled the holes and passed it through with the others thinking it would not be noticed, and no doubt not realizing that the result might be serious. It was fortunate that the odd brush was not one of the first four tested, as the grade would probably have been condemned without the error being located or a further test being conducted. This should illustrate very forcibly the necessity of having all brushes on a machine of the same grade. It might be added further that the combination operated much worse than either set alone in regard to picking up copper as well as sparking.

Before brushes are installed, the commutator should be put into first class condition. A loose commutator bar may not be high when the machine is not running but may be projected above the surface by centrifugal force when the machine is running at full speed. The commutator bolts should first be tightened with a long bar wrench, after which the commutator should be turned, ground, or stoned as may be needed or practicable. If the commutator runs true and is not worn in ridges, stoning with a fine grained sand stone hollowed to fit the curvature of the commutator and four or five inches long should be sufficient. If the commutator has ridges worn in it from the previous brushes or if it runs with an appreciable eccentricity or has large flat spots it should be turned or ground.

If the machine is mechanically balanced, turning is as good as grinding if it can be done without removing the armature from the machine bearing. If the armature is removed and placed in a lathe the shaft should be tested for eccentricity before the commutator is turned. The best way to put the commutator into the best condition is to operate the machine at full speed and grind the commutator with a small grinding wheel running in the opposite direction to that of the commutator and mounted on a guide in such a manner that the wheel can be moved backward and forward across the commutator exactly parallel to the shaft.

After the commutator is smoothed, if the mica is to be undercut, precautions should be taken as outlined in section 3 of the July issue. After the commutator has been put into first class condition the brushes should be put into their holders and sanded to fit the commutator roughly with coarse sand paper drawn back and forth under the brushes. The brushes should then be very carefully spaced around the commutator as a variation of ⅛ of an inch or sometimes even less will cause serious short circuit currents between brush studs. Methods for checking brush spacing were outlined in section 2 in the June issue. Care should also be taken to see that the brush studs are all straight with axis of the commutator and that all brush holders on each stud are in alignment. To do this see that every brush on each brush stud is the same distance from the edge of the nearest commutator segment as is the brush which was used in checking brush spacing.

After these adjustments have been made, again sand paper the brushes with a medium sand paper. During the preliminary sanding to facilitate rapid work, a high pressure may be applied to the brushes either through the brush holder spring if adjustable or any other available means. With the brush pressure adjusted to the operating value, a final sanding should be made with No. 00 sand paper, drawing the sand paper in the direction of rotation of the commutator only and lifting the brush while moving the sandpaper in the opposite direction. It requires two men to work this last sanding rapidly. After the sandpapering has been completed, if the brushes can conveniently be removed from the holders each brush face should be wiped to remove any particles of sand and the commutator should be cleaned for the same purpose. If, however, the brush holders are of the clamp type, the brushes instead of being removed should be lifted and the faces and commutator cleaned with compressed air. If the brushes have been installed as outlined above the load may be put on the machine at once but when possible it is better to let the machine run light a few hours to give the brushes and commutator a chance to polish.

After the load has been put on the machine if there is any sparking, the brush yoke should be shifted until the best operating point is found. The neutral point is often quite different for different grades of brushes owing to the difference in contact resistance.

Remember that brush pressure is very important. Generally speaking the pressure should be not less than 2 pounds per square inch and only high enough to insure perfect contact between brushes and commutator at all times. It is essential that the pressure be uniform to obtain an equal distribution of load on all brushes. If the brushes are equipped with shunts, care should be taken to see that all shunts are securely attached to the brushes and all terminals of the shunts should be firmly fastened to the brush studs.

When going over the machine it is well to inspect the bearings and gage the air gaps between the armature and each pole face, as unequal air gaps are responsible for much of the sparking troubles which are encountered. The effect of unequal air gaps is not as serious on wave-wound as on lap-wound machines, we mean one in which the winding progresses entirely around the armature passing under every pole face for an advance of one commutator bar. By a lap-wound machine, we mean one in which the winding passes under only two pole faces before returning to the adjacent commutator bar. The wave winding is sometimes known as a series winding and the lap winding as a parallel winding. On the wave-wound machine the effect of unequal air gaps will be more or less balanced by the winding passing under all the pole faces and for this reason short circuit currents will not be excessive. In a lap-wound machine, however, if one pole face is a little nearer the armature than another pole face, there may develop in that section of the armature a higher voltage than developed in another section.

The magnitude of these short circuit currents may frequently be so great as to actually reverse the direction of the current in one or more of the brush studs on the machine. If the unequal air gaps are due to worn bearings or poor centering of the shaft in the bearings, the trouble may readily be corrected by putting the bearings in good condition. If, however, the trouble is with the pole faces themselves the best method of correcting the error will depend somewhat on the operating characteristics of the machine. If the brushes have a tendency to spark with changes of loads it is well to cut down the long pieces to increase the average length of the air gap, which will reduce the tendency of the neutral point to shift with variations of load. This, however, should not be done unless some resistance is left in the field circuit which can be cut out to increase the field current sufficiently to force the same magnetic flux through the increased air gap, or unless the speed of the machine can be slightly raised. If the electrical neutral point does not shift with variations in loads, the pole pieces may all be "shimmed" to equal the smallest air gaps by placing thin sheets of metal between the ends of the pole pieces and the frame of the machine.

If all of these points are carefully watched when the brushes are installed the life of brushes and the service received from the machine will be greatly increased.

Electrolysis of Underground Pipes and Structures

BY BENJAMIN F. THOMAS, JR.

THE electrolytic corrosion of underground pipes and structures when located in the vicinity of electric railway systems using a direct current grounded track return has been considerably discussed of late, and under investigation by the Bureau of Standards at Washington, D. C., and by the American Electric Railway Association. Both of these sources have published considerable information on causes and possible remedies. However, the experimental stage has not yet passed, and on this account it may be expected that during the next few years vital data will be available to support or modify the theories now being advanced. In what follows some general remarks are presented on this subject, being abstracted from a discussion in a recent issue of the *Union Electric Bulletin*, the publication of the Union Electric Light & Power Company, of St. Louis, Mo., where recommendations of the Bureau of Standards to prevent electrolysis are being carried out.

In the case of electrolysis of underground pipes and structures due to current from electric railway systems, the car rails and the underground pipes form the nodes and the moist earth between the electrolyte. According to Faraday's Law, the electrolytic corrosion is proportional to the strength of the current and the length of time that this current passes between the nodes. Expressed in pounds per year, this means that approximately 20 pounds of iron, 23 pounds of copper and 74 pounds of lead will be corroded per year for each ampere of current leaving the pipes.

Were the earth perfectly dry, electrolysis would not occur because of the high specific resistance of dry soil, but as the condition of dry earth rarely, if ever, occurs, there is always an interchange of current of more or less magnitude between the tracks and the pipes. The average amount of moisture contained in the soils in St. Louis is 20.9 per cent, and the average specific resistance is 1,053 ohms per cubic centimeter. These values are results of tests made by the National Bureau of Standards upon 35 specimens. The resistance of each specimen was determined while it contained the same amount of moisture as when taken from the ground. The percentage of moisture is expressed in terms of dry earth.

At points at a distance from the generating station, or substation, the rails are usually the positive pole and the underground pipes the negative pole, but nearer the station the reverse is true; the pipes are positive to the rails and the pipes are corroded. This corrosion is proportional to the strength of the current leaving the pipes through the earth. The "efficiency of corrosion" of underground pipes—that is, the ratio of the actual corrosion due to electrolysis—to the theoretical value, as determined by Faraday's Law, is often greater than 100 per cent. In the tests made by the Bureau of Standards they found that the average value of all the tests was near or above the theoretical value, and in some individual cases the actual corrosion was 40 to 50 per cent greater than the theoretical.

The manner in which the current is collected upon the pipes is as follows: At any point on an electric car line, when a car passes by, a circuit is made between the trolley and the track and the current flows through the car from the trolley to the track and thence back to the power house. This return current will flow back along the rails, through the ground, and along the underground pipe lines, these three paths forming a divided circuit, the magnitude of the current in each being inversely proportional to its resistance. Hence, if the pipe line offers less resistance than the track, the larger portion of the current will flow back through the pipes, provided that the earth at the points where the current flows to and from the pipes does not offer too great a resistance. It is, therefore, of importance to keep the resistance of the pipe line as high as possible.

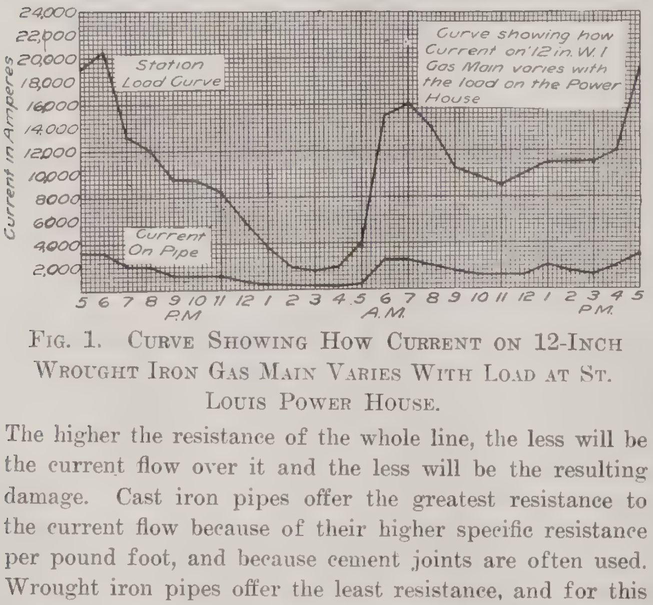


FIG. 1. CURVE SHOWING HOW CURRENT ON 12-INCH WROUGHT IRON GAS MAIN VARIES WITH LOAD AT ST. LOUIS POWER HOUSE.

The higher the resistance of the whole line, the less will be the current flow over it and the less will be the resulting damage. Cast iron pipes offer the greatest resistance to the current flow because of their higher specific resistance per pound foot, and because cement joints are often used. Wrought iron pipes offer the least resistance, and for this reason insulating or high resistance joints are frequently inserted in the line. However, unless these insulating joints are installed entirely throughout the system, they must be used judiciously or they will cause greater and more diversified damage than if they were not used at all.

To determine to what extent and in what localities damage is being done upon the underground systems, electrolysis surveys are made. These surveys consist of voltage readings taken between the pipes and the street car tracks, adjacent steel structures which may be carrying current, or between two different systems of pipes. The voltage tests are augmented by current measurements to determine the flow on the pipes. The apparatus necessary consists of a voltmeter and two poles, or rods, with sharpened iron points, to each of which is attached about 35 feet of copper wire with a good rubber-covered insulation. A No. 14 or No. 16 B. & S. gauge stranded copper wire is very well adapted for this purpose, offering but little resistance, and being very flexible and easily handled. The voltmeter should have two or more ranges, with at least one range giving a full scale deflection for a volt or less. The second range should be about 5 or 10 volts, while the third should require about 50 volts for a full scale deflection. It is also necessary that the instrument should be double reading—that is, that the zero is in the center of the scale. A very convenient instrument to use in these surveys, and one that can be used for both voltage and current measurements, is a Weston model No. 1 combination voltmeter and millivoltmeter, having the following ranges:

50	0	50	volts.
5	0	5	volts.
0.5	0	0.5	volts.
0.05	0	0.05	volts.
0.005	0	0.005	volts.

This instrument is recommended by Prof. Albert F. Ganz, one of the foremost experts on electrolysis in this country, and has proven very satisfactory.

In making the voltage measurements, the point of one pole is placed upon one of the rails of the car track and the other pole is placed on the pipe line, and the wires from the poles attached to the instrument. In order to obviate the necessity of making excavations to reach the pipe for each measurement, valves, corporation cocks, curb cocks, drip risers, water hydrants, and even the gas lamp posts, are made use of, very good electrical contact being made in this manner with the brass parts of the fittings.

For current measurements the voltage drop is observed over a measured length of continuous pipe, and the current determined by Ohm's law, the resistance of the pipe being obtained from tables based on an average specific resistance per pound foot of pipe. Where current measurements are made, it is necessary to strip the pipe for about six feet, and at points where they are to be taken frequently, wires are attached to the pipe and brought up to the surface, so that the excavation need not be made every time a measurement is desired. In this case the wires are driven into a small gash cut transversely into the pipe, soldered on or attached with saddles, and are spaced from four to six feet apart. They are then brought up to the surface of the ground and left in a stop-box located in a convenient place.

After the whole system has been worked over, the results of the survey can be plotted upon a skeleton map, showing the pipe lines and the electric car tracks, and the positive and negative areas determined. The direction of the current flow can also be plotted upon the same map. This will afford an excellent means of studying the trouble systematically and of working out a method of preventing future trouble.

A great deal has been written and a great many experiments conducted in an effort to find some means of preventing electrolytic corrosion, but no remedial measures have been formed. Insulating joints and coverings, cement coverings, encasing the pipes in clay or fiber conduit, insulating joints and bonding the pipes either to the rail or directly to the negative bus bar at the generating station. Protective coverings for the pipe line give but scant protection, because the moisture in the earth sooner or later penetrates the covering, and they are then of no use whatever. Insulating joints, when their insulating qualities are

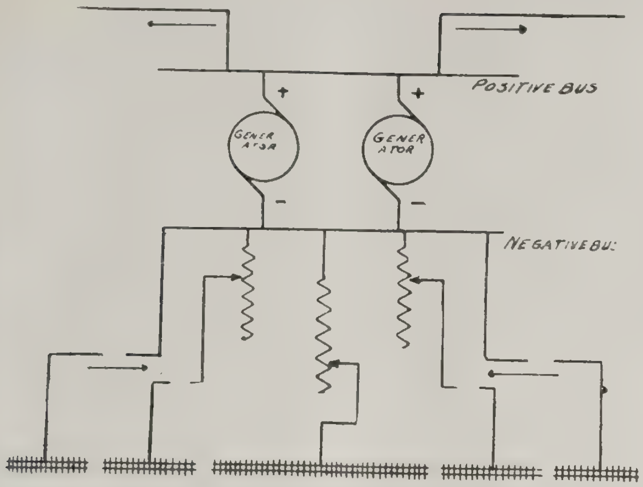


FIG. 2. PRINCIPLE OF INSULATED NEGATIVE RETURN SYSTEM AS RECOMMENDED BY BUREAU OF STANDARDS FOR ELECTROLYSIS MITIGATION.

permanent, afford an efficient means of limiting the current flow on pipe lines if they are placed in the negative areas of the system, where the current tends to flow to the pipes; but where placed in the positive areas, not only do they do no good, but greatly increase the damage by causing the current to flow through the earth around the joint, causing electrolysis at one side of each joint. The effect of bonding the pipes to the rails or negative bus bar may stop the damage at one place, but the bonding, by reducing the resistance of the whole pipe line, causes the pipes to carry a much larger current, and this will cause greater damage to be done at insulating joints and other places which may have a high resistance. The net effect of bonding is to increase the trouble and the cause to appear in unlooked-for places. However, all of these methods are palliative, and not preventive.

The most permanent way to stop electrolysis is by attacking it at its source—that is, by making the electric railroads keep the current out of the ground. To do this entirely would necessitate a double-trolley system, as is now used in Washington and Cincinnati. With a track return system, by limiting the potential drop along the rail, the damage can be reduced to a point where it is no longer of a commercial importance. This is the method that is now most commonly used. A great many European countries limit the drop to three volts per mile, but in this country the allowable drop varies from twelve to twenty-five volts per mile. The Bureau of Standards, after a thorough investigation into the subject of electrolysis mitigation, has decided that an allowable drop of one volt per thousand feet is a value that will safeguard the underground structures and at the same time will not cause a hardship upon the railroads to bring the drop within this limit.

The method of reducing the voltage drop that is recommended by the bureau is what is known as the "insulated negative return system," the features of which are shown in Fig. 2. This method consists of bonding the tracks to the negative bus bar at the station by means of copper cables insulated from the ground. These negative feeders are tapped into the track at the proper intervals to reduce the potential drop along the rails to the required value. To limit the amount of copper that it is necessary to install, a variable resistance is inserted in the feeders that tap the tracks at points near the station, and in this manner the potential drop can be regulated so that it is the same on all feeders. This insures the proper division of the return current, and the voltage drop of the tracks can be regulated to an economical value, and can be made uniform over the entire length of track. This installation of so much copper seems at first to be prohibitive, but the Bureau of Standards has proven, in its work in St. Louis in 1912, that it is an economical feasibility in so far as the amount of energy saved will overbalance the cost of the installation. With regard to the legal status of the question, although there has been a great deal of litigation, it has not been definitely decided by the courts whether the railroads can be held responsible for electrolytic damage. However, the tendency is that the electric railroads will be held responsible for the current flowing through the earth and over the pipes, and will be made to install such measures as will do away with or reduce to a negligible value the electrolysis of underground structures.

Drying Out and Installing Large High Voltage Transformers

BY EDWARD W. GUNDEL, B. S.

BEFORE any large capacity, high voltage machine or transformer can be placed in service, the windings must be thoroughly dried—the insulation must be free from moisture. This important factor becomes more apparent as the voltage of the apparatus increases, and is a question which cannot be overestimated. At present transformers are operated on 150,000 volt circuits and as the manufacturers usually give all transformers an over potential test of from 75 to 100 per cent, the question of good dry insulation asserts itself. A transformer may have a very low core loss, excellent regulation and the temperature tests exceedingly low, yet if the insulation is weak or defective through moisture in the windings or otherwise, the transformer fails in the one thing above all others for which it was designed.

As all large capacity transformers are of the oil insulated, water cooled type, this type only will be considered. The smaller transformers are usually dried out, sealed with their oil in the tanks and shipped ready for service, the size being limited only by difficulties encountered enroute.

There are four methods of drying out insulation of transformers. (1) By internal heat; (2) by external heat; (3) by internal and external heat; (4) by applying internal heat and placing the transformer under a vacuum in its own tank. This last method is used on high voltage transformers only while the first three are used on the smaller types of power and distributing transformers. After the transformer has been completely assembled at its point of destination, the tank is carefully sealed, lead gaskets placed under all the bushings and the cover, and all the bolts pulled down tight. It will be found that these bolts will become loose after the vacuum is put on, it being necessary to go over these several times before the vacuum is fully established. A trap is placed in the vacuum line anywhere between the vacuum pump and the transformer—preferably as near the transformer as possible. This tank should hold at least three or four gallons and if this size trap is used, it should be emptied every two hours for the first day or two as it will be surprising how much moisture or "muck" is extracted from the transformer in the early stages of the drying process. The vacuum line should run direct to the lowest part of the bottom of the transformer. This may be accomplished by means of reduced bushings through the oil outlet at the base of the tank. Valves are placed on either side of the trap so as not to destroy the vacuum in the transformer when the trap is being emptied.

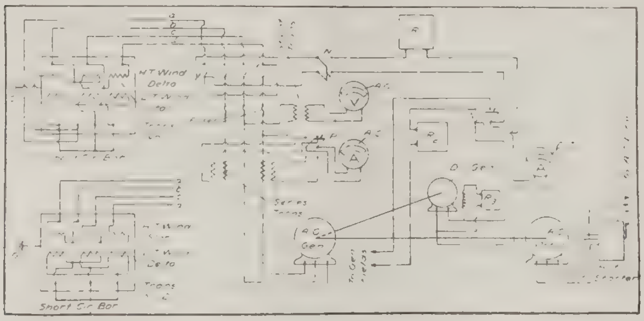


FIG. 1. CONNECTIONS FOR DRYING OUT LARGE TRANSFORMERS.

A temporary switch board may be erected and the drying outfit, usually a motor generator set, be wired up as shown in Fig. 1. It will be found convenient to have all apparatus located as near the transformer as possible. With this motor generator set is included a small D. C. exciter which is used for exciting the A. C. generator field when current is being applied to the high tension side of the transformer, (the low tension being short circuited) and also for measuring the resistances of the phases, *viz.,* by opening switch M and closing N the D. C. generator supplies current to the A. C. generator field and by opening N and closing M the current is used for measuring the resistance across the three phases.

The sketch shows two transformers, the windings of one being connected delta-star and the other star-delta. The latter is generally used for stepping up, while the former is used on the same circuit for stepping down. In the first case where the windings are connected delta-star, it becomes necessary to disconnect the neutral from the low tension terminal and break one of the Delta connections on the high. The fourth wire then for measuring the resistance across this phase is brought out through the neutral on the low. After the resistance is taken the delta connection on the high is again established through the wire *XY* when the generator switches are closed. Resistance measurements are then taken across *ab-bc-cd* respectively, the voltmeter leads (not shown in sketch) being held on these points while the resistance is being taken and laid aside when A. C. current is applied to the transformer.

In the second case, however, it is not necessary to make any changes on the inside of the transformer, all connections being made direct from the terminals on the outside. Resistance measurements, however, are taken across the leads $a'b'$-$b'c'$-$b'd$.

The transformer is gradually heated up until it reaches a temperature of 80 degrees C., where it should be held constant throughout the drying period. As the transformer is sealed and under vacuum, it is impossible to determine the temperature of the coils by thermometers, therefore it is very essential that careful resistance readings be taken, as a very small variation in resistance will cause quite a difference in temperature from that which really exists. Special care should be taken with the cold resistance since all the temperatures are based on this one. Three readings should be taken across each phase by means of the variable resistance R_1 or R_3 and the average of these readings be used in calculating the temperature. These measurements should be taken every half hour at first until the transformer reaches the desired temperature and less frequently thereafter.

Insulation resistance should be measured every day, taken at or nearly the same temperature each time, as this resistance is much higher at a lower temperature than when the transformer is hot. Unfortunately this measurement is not ordinarily a convenient one to make because of lack of facilities. A "megger" naturally suggests the simple method of measuring the resistance, however, as a rule this instrument is not always available. Another simple method that is often made use of when such a circuit can be obtained is to use a direct current circuit of 500 or 600 volts and a high resistance voltmeter. Connections for this method are shown in Fig. 2.

The voltage across the line is first measured and then the resistance to be measured is connected in series with the voltmeter and the readings again noted. The insulation resistance is then determined from the formula:

$$R = r\,[(V - v) \div v].$$

Where R = Insulation resist. to be measured; r = Voltmeter resistance; V = D. C. Voltage across the line; v = Voltage reading with insulation resistance in series with voltmeter.

Great care should be taken to have all wires well insulated, better results being obtained if wires are stiff enough to support themselves. If a curve be plotted with time as abscissae and resistance as ordinates, one will notice a rising and falling in the curve from day to day due to the moisture being slowly driven out. When two or three consecutive readings taken at the same temperature and same time each day give approximately the same insulation re-

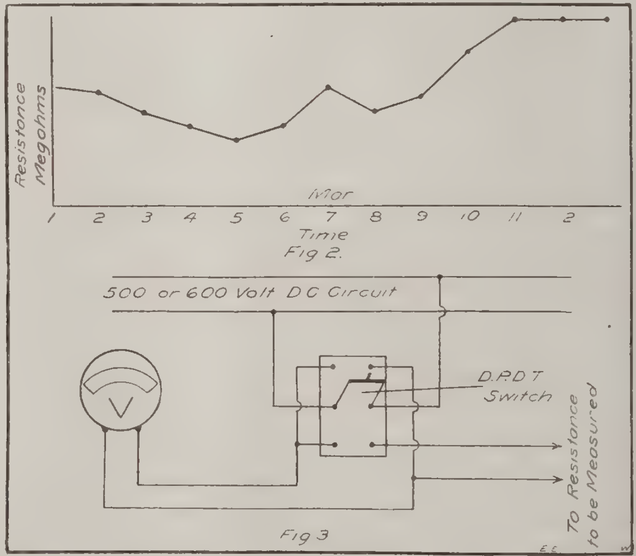
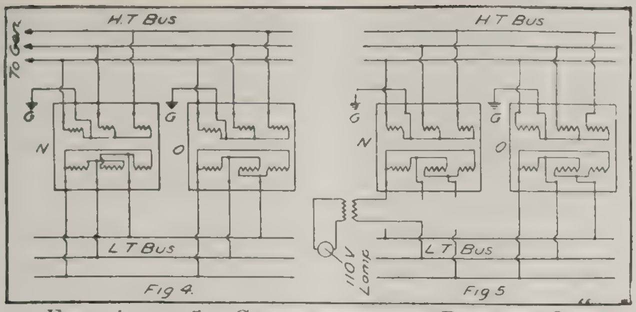


FIG. 2. CONNECTIONS FOR MEASURING INSULATION RESISTANCE. FIG. 3. INSULATION RESISTANCE CURVE.



Figs. 4 and 5. Connections for Phasing Out Transformers.

sistance, one may be reasonably certain that the transformer is dry. The curve will be similar to that shown in Fig. 3.

With this process or method of drying, the transformer is not only dried thoroughly but uniformly. It also permits the oil to be admitted to the tank under vacuum after drying, thus eliminating any chance for air bubbles to form in the interstices of the windings and insulation. This is a very important factor in large high voltage transformers where it is essential that the oil be entirely free from air.

There can be no definite length of time set for drying transformers as some require more than others, ranging from one to three weeks, depending entirely upon the condition of the transformer, its size and voltage. A transformer should not be placed in service, however, until no more "muck" can be obtained from the trap nor before the insulation resistance measured at 80 degrees C shows a reading of at least one megohm for each 1000 volts rating of the transformer. It can readily be seen that the vacuum method is somewhat expensive and complicated, but in the case of large high voltage transformers the results and the satisfaction obtained justifies the expense.

Supposing the transformer to be now dry, with the oil in the tank ready to put in service, there are two methods of phasing out and placing the transformer on the line. The first, shown in Fig. 4, is by far the simpler and quicker method, but not always available. The new transformer (N) is connected in across the bus bars with any one of the other transformers (O) but on a separate bus from the load. A single generator is used to furnish the required voltage—this generator being used first to gradually build up the voltage on the new transformer. If the new transformer (N) is out of phase with (O), there will be a circulating current which will show on the ammeter. However, if the transformer is in phase there will be no circulating current and can, therefore, be put in service.

The second method is to connect the transformers across the buses, same as Fig. 4, except that the low tension side is left open in such a way that a testing transformer may be placed across the phases as shown in Fig. 5, a test lamp being inserted in the secondary side of this transformer. If the lamp remains dark across two of the phases (N is in phase with (O). However, if the lamp is lighted, the transformer is out of phase, in which case the leads must be changed about until such a condition exists where the lamp remains dark.

When the transformers are in phase the load may be brought up to its full capacity, care being taken that water is flowing through the cooling coils, otherwise the temperature of the transformer will rise to a dangerous degree in a very short time.

The Relation of Plant Size to Power Cost

BY P. M. LINCOLN.

A Discussion of Three Reasons Why a Large Plant Can Supply a Demand More Economically Than a Small Plant.

In what follows a discussion is presented on features of large plant design and operation to show that a large plant can supply a given power service as a part of a general power supply business more economically than a plant of only sufficient size for that given service. The discussion presented here is an abstract of a paper delivered by Mr. Lincoln at a meeting of the American Institute of Electrical Engineers at Philadelphia, Pa., in October, 1913.

There are three distinct reasons why a large plant can take care of a given service more economically than a small one. These reasons are: 1. Because the first cost per kilowatt of the large units entering into the construction of a large plant is lower than the small units entering into the construction of a small plant, thereby reducing the first cost of the apparatus necessary for the given service, and, therefore, reducing the annual fixed charges thereon.

2. Because a large plant inherently can be operated more economically than a small one, and because, further, the large plant can afford to introduce economies which would be out of the question in a small one.

3. Because of the existence of diversity factor, whereby one kilowatt of capacity in a central station will serve a combined load that would take considerable more than one kilowatt if each part of that combined load were to be served separately. A discussion of these three reasons will be taken up in the order named above.

RELATION OF SIZE AND FIRST COST.

A large plant will cost less per kilowatt than a small one. This is simply a specific statement of a general law. The larger the amount involved the cheaper each unit becomes, no matter what the commodity may be: Kilowatts come cheaper when purchased a thousand in one machine than when bought singly; just as cigars come cheaper by the box, or freight rates are lower by the carload. Although this law is usually recognized qualitatively, few engineers have an adequate conception of how much it means quantitatively. To give some idea of the extent to which this reduction in cost occurs, a number of curves are given herein showing approximately how much the size affects the cost per kilowatt of some of the types of apparatus that enter into the make-up of a power station. In giving these data, logarithmic cross-section paper is used for two reasons—first, because the range of the data covered in a given curve may be thereby increased, and, second, because the law connecting size and cost per kilowatt usually takes an exponential form, thereby enabling us to represent the relation by a straight line on this kind of paper.

In Fig. 1 data of this nature is given for electric generating apparatus. In apparatus of this kind a variation in size is almost invariably accompanied by a simultaneous variation in speed, and both speed and size have an important influence upon the cost per kilowatt. It is quite possible, however, to take cognizance of the speed variation as well as the output variation, and to derive a law that couples the cost per kilowatt with both output and speed. The data given in Fig. 1 are the result of the inspection of a considerable number of electric generator costs. This curve shows the relative variation of cost per kilowatt as it depends upon size and speed of generator units. An inspection of the curve will show, for instance, that if the speed remains constant the cost per kilowatt will decrease by approximately 65 per cent for an increase of ten-fold in the size of the unit.

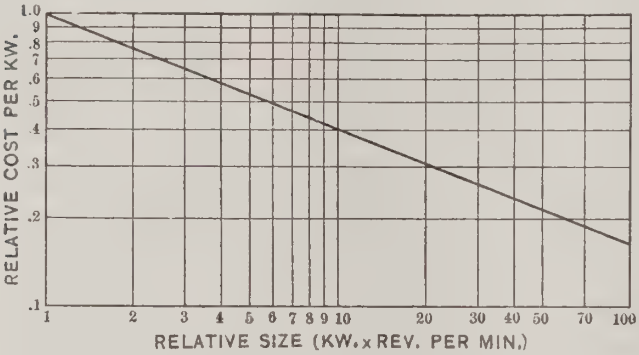


Fig. 1. Cost Data for Generators.

In Fig. 2 similar data are given for some typical lines of transformers, and in Fig. 3 data are given upon the relative costs of different sizes of boilers.

In using any of these curves it must be borne in mind that a curve is simply a method of stating a general law, and that no such general law can take cognizance of an unusual condition. For instance, if we tried to extend the curve for 110,000-volt transformers so as to obtain the cost of a one-kw. transformer, the result would be absurd. When an engineer has designed the smallest possible transformer suitable for use on 110,000 volts, he will necessarily have a transformer of a capacity very much in excess of one kilowatt. In other words, it is impossible to design a transformer of so high a voltage and so low an output. As a consequence, therefore, the use of these curves to obtain relative costs for such conditions would lead to a result which is sadly in error. Common sense must be used in the application of these data.

Comparing a large central station suitable for delivering power for every purpose with the size of a plant that an individual customer of that central station would have to install, if he supplied his own wants, we will find, of course, that the central station plant will be very much larger, anywhere from ten to a thousand fold, possibly even more. However, in comparing complete plants with such a difference in size, we will find that we do not realize the whole of the difference in cost that would be indicated by comparing the difference in the cost of the individual parts. The reason for this is that the large plant is inherently more elaborate than the small one. A large plant will naturally be equipped with such items as mechanical stokers, coal and ash handling machinery, coal bunkers and storage yards, superheaters, economizers, condensers with all their auxiliaries, double sets of bus bars, distant control electrically operated switches, heat insulating lagging on all boilers and steam pipes, feed water heaters, water softening plant, etc., some or all of which items may be omitted from the small plant. Although such items cause an increase in the first cost of the large plant, they still do not run its cost up to be as much per kilowatt as the small plant not equipped with these refinements. In the large plant the first cost of these items is more than offset by the operating cost which their use will save, and that fact accounts for their use. On the other hand, as the size of the plant is reduced, the point is approached where these cost-saving items may, one by one, be eliminated, owing to the fact that their presence will lead to a greater resultant cost of power than their absence. It is only where power is produced in relatively large quantities that these various cost-saving devices will pay. This matter will be treated further under the next heading in this paper.

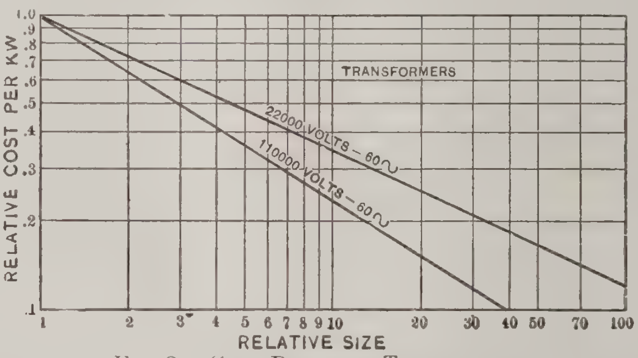


Fig. 2. Cost Data for Transformers.

Another saving which would be effected by concentrating power-producing apparatus at a single point instead of distributing it throughout the premises of the various customers served is the tremendous aggregate saving in space. As the size of the unit increases, the saving in space occupied becomes marked. For instance, a 10,000-kw. turbo-generator does not take up anything like ten times as much space as a 1,000-kw. generator. In fact, the space occupied is but little more than for a 1,000-kw. unit, and when we compare the space occupied by a 10,000-kw. unit with a 100-kw. unit, the discrepancy is still more marked.

The aggregate saving in space occupied in housing of plant and in the auxiliary equipment will evidently amount to a large item, and the comparison of central station power versus individual plants will result in a very material reduction in the first cost of the former compared to the latter.

ECONOMIES DUE TO A LARGE PLANT.

The reduction in first cost per kilowatt of a large plant

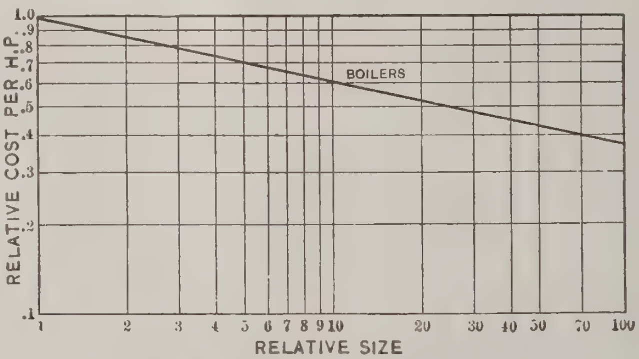


Fig. 3. Cost Data for Boilers.

over a small one is by no means the only economy from the concentration of a large amount of power-generating apparatus at one point. In fact, the reduction in first cost is only a small part of the total saving that can be obtained by such a move.

The total cost of power may be divided into two parts--viz: first annual fixed charges (interest, depreciation, taxes and insurance), that depend upon the first cost, and, second, operating costs (fuel, labor, repairs, supplies, and superintendence), that are almost entirely independent of the first cost. We have just seen that size has a considerable influence on the first of these divisions, and now we propose to show this influence is still more marked on the second division. The proportion that fixed charges enter total power costs is usually somewhere between 30 per cent and 60 per cent, being smaller with small plants. The reason that fixed charges increase in proportion as the size of the plant decreases is not on account of the inherent decrease of this item (because, as we have already seen, it really increases), but because operating costs increase with decrease in size much faster than do fixed charges.

A preceding paragraph of this discussion has called attention to the fact that the larger the plant the greater refinements it can afford to install. The first matter that requires attention as the size increases is usually the matter of fuel saving. In large plants the cost of fuel usually amounts to somewhere between 50 per cent and 75 per cent of the total operating expense. Obviously, therefore, the fuel bill offers by far the best target when one goes hunting for economy. In plants of small output the fuel bill bears a smaller proportion to the total, not at all because of better economy, but because the other expenses, such as labor, superintendence, etc., go down slower than does fuel as the plant size decreases.

The condenser is undoubtedly the most important piece of apparatus so far as fuel economy is concerned. A large plant is almost invariably placed where suitable condensing water can be obtained, whereas a plant for serving the individual customer has to go on that customer's premises, and even if the expense of a condenser is warranted, in a great many cases suitable condensing water is not available except at a cost which makes its use prohibitive. The inherent fuel economy of condensing units as compared with non-condensing units is nearly in the ratio of two to one, and it can, therefore, be seen at once how large a factor the condenser becomes in the matter of economical operation.

As the plant increases in size we soon come to a point where an investment in superheaters and economizers will begin to pay. The economy effected by these devices in a large plant is of the order of about 10 per cent of the fuel. When our fuel bill is of the order of 50 per cent of the total cost of power, it is evident such a saving will justify a very considerable expenditure. As the plant output grows smaller, however, the fuel bill becomes a constantly decreasing proportion of the total cost, and at the same time the relative cost of superheater and economizers increases, so that we soon arrive at a point where their installation will no longer pay. It is only the plant of comparatively large output that can afford to use this economy.

Uniformity in fuel supply is another item which is of very considerable importance, as is realized by those who have been obliged to change the quality of fuel fired from time to time. The grates, draft, combustion chamber, etc., suitable for one kind of fuel may not be at all suitable for another, and the insurance of a uniform fuel supply is not within the power of the user of fuel in comparatively small quantities. It is only large plants which buy fuel at wholesale that can afford to have a guaranteed and uniform supply. The purchase of fuel under specifications is a refinement in fuel practice that has come into very considerable vogue within the past five or ten years. It is only such plants as use fuel in large quantities that can avail themselves of the uniformity of fuel supply which the purchase of fuel under such specifications will insure.

Some of our larger central stations have found that uniformity in the size of the particles of fuel has an important bearing on the economy with which it can be burned under boilers. In some plants it has been demonstrated that it is economy to screen the fuel so that dust and small particles may be separated from the larger and burned in a separate furnace particularly designed with that end in view. It is evident that only a plant having a comparatively large fuel consumption can afford to enter into such a refinement in the use of its fuel. Here is another economy that is available only in a larger plant.

After fuel, labor is the next largest of the items that go to make up operating cost. In the large plants it is possible to introduce labor-saving devices that would be out of the question in the small plant. Probably one of the greatest labor-saving devices in the modern power plant is the mechanical stoker. Not only does the mechanical stoker save labor, but it also gives an ability to force boilers to a point not possible with hand firing. Thus an indirect saving comes from the use of mechanical stokers (in reducing boiler equipment necessary during peaks) that is as great, if not greater, than their effect in the direct saving of labor. In the small plants the installation of mechanical stokers is not justified, because, even with hand firing, the boiler room force is so small that it could not be further reduced by introducing stokers.

Again, when we come to analyze engine room labor, it is evident that a 10,000-kw. turbo-generator does not require much more attention than a 100-kw. unit. Each unit has about the same number of bearings, and there is little inherent reason for the large unit requiring much more attention than the small one. When we compare them on a per kilowatt basis, the large unit, of course, has a tremendous advantage in labor cost.

In a small plant we will find that the coal supply is brought in from the coal pile in a wheelbarrow and shoveled into the furnace by hand. In the large plant the incoming coal is dumped by gravity from a hopper car and carried almost automatically by machinery into bins above the furnaces, where it is fed by gravity to the grates. The difference in labor is, of course, very marked, but it would be ridiculous for the small plant to attempt to use such coal-handling machinery, because the amount of labor which it could save would not begin to pay for the fixed charges on the machinery.

The removal of ashes is another point wherein the large plant has an advantage on account of its size. The small plant must have them raked out by hand, loaded into a wheelbarrow and hauled away to a pile that is again moved by hand when a sufficient amount has accumulated. The large plant dumps them into a tram car, that takes them directly to a hopper car for disposal at once.

Another item of economy which can be exercised by the large plant, but is prohibited to the small one, is that of adjusting the apparatus to the load to be carried. A large plant usually is equipped with a comparatively large number of units and can operate them so that the units are run near their maximum economy point. On the other hand, a small plant is usually equipped with a relatively small number of units, and must often run a unit considerably larger than necessary to take care of the load, and consequently operate it at a relatively low point on its economy curve.

And so one may go on indefinitely and enumerate the advantages and economies of the large central station. If the boiler feed water is bad, the large plant can afford to install a water softening plant; the small plant cannot think of such a refinement. The large station can afford to insure itself against a coal miners' strike by installing a coal storage yard, and to insure itself against electrical breakdowns by spare units, spare cables and a double set of buses—refinements that would be entirely out of reach of the individual small plant.

It is evident, therefore, from the foregoing analysis that not only does the central station have an advantage in first cost, but that it has a much greater advantage both in operating cost and in the ability to insure continuity of service.

DIVERSITY FACTOR.

Now we come to the third advantage of the large central station serving a diversified load. As the name indicates, diversity factor might be defined as the advantage in capacity which is secured by the large plant serving many different kinds of loads over the aggregate capacity of the many plants that would be required to serve each individual part of this load separately. Not only is the large station cheaper per kilowatt than the small one, but also the large plant does not have to have as many kilowatts of capacity installed to take care of a given aggregate load as would individual plants for taking care of the same service.

The diversity of two or more loads may be complete or only partial. Diversity may also occur on account of either yearly or daily fluctuations in the time that the maximum of a given load occurs. As an example of yearly fluctuations, we might cite, as summer loads, ventilating fans, irrigation, pleasure parks and ice making; as winter loads, electric heating (as for street cars and houses) and electric lighting during the early hours of the daily lighting period. As examples of diversity factor due to daily variations, we might cite power for the operation of factories during the day and the power required for illuminating the streets at night. These are examples where the diversity is nearly, if not quite, complete, as there is no coincidence whatever of the times at which such loads must be carried.

Partial diversity is always secured between two loads unless the loads vary in exactly the same proportion at exactly the same time. Such a coincidence is impossible, and, as a consequence, any loads will have some diversity in the times at which their maxima will be taken.

One of the best examples of diversity that the writer knows of is the use of one of the United States government irrigation plants in the west for house heating during the winter months—a use which was called to my attention by Mr. O. H. Ensign, chief engineer of the United States reclammation service. The power plant in this case was installed primarily for the purpose of pumping water for the irrigation of some of the arid lands of Idaho. The irrigation season in Idaho opens in April and closes usually in September, operating for this purpose only during the summer months. During the winter months there is ample water to run the plant, and practically the only expense of its operation during the winter is the labor necessary for attendance. It is evident that the machinery will have less depreciation if operated during the winter months than if simply shut down and left uncared for. There is not the same chance for the apparatus to absorb moisture, and it will unquestionably be in a better shape for this operation than if not operated during the winter.

In this Idaho irrigation district advantage is taken of this condition by supplying electric heat to the farmers during the winter months at a price that will simply pay the cost of operation. This policy results in a price of the order of one-tenth cent per kw. hour. With such a price, one dollar will buy 3,420,000 B.t.u. With coal running 10,000 B.t.u. per pound and selling at $4.00 per ton (which is certainly a favorable statement of the fuel conditions in this district), one dollar will buy 5,000,000 B.t.u. An efficiency of 50 per cent is certainly all that can be expected in burning fuel for house-heating purposes, while with electric heat one cannot avoid an efficiency of 100 per cent. As a consequence, we have the condition where the farmers of Idaho are able to heat their houses by electricity actually cheaper than by coal, to say nothing of the greater convenience and cleanliness of the electric method of heating—and this all comes on account of the existence of diversity factor.

Complete diversity occurs only with certain limited kinds of service; partial diversity occurs on every kind of service. The amount of partial diversity which occurs depends entirely upon the nature of that service. Mr. H. B. Gear, in an interesting paper read before the Chicago section of this institute in 1910, gives some valuable data on the question of diversity facor. He found, for instance, that in residence lighting the diversity factor amounted to over 6—that is, the sum of the maxima of a considerable number of residences was over six times as great as the maximum required from the generating station to serve all of these residences. For commercial lighting—that is, the lighting of retail stores, etc.—he found a diversity of nearly 2½; for small, scattered service he found a diversity of practically the same figure, and for large users the diversity was still 1.4. Possibly this last figure is the most significant of all. It is the large user who would be tempted to install a plant for his own operation. Residence lighting and small, scattered power, etc., use such a small quantity of energy that there is practically no incentive for such users to provide their own power. However, the fact that the large user still has a diversity as high as 1.4 is of itself sufficient to enable a large central station to supply power to such users cheaper than they can make it themselves. This one consideration, independent of the others that are discussed in this paper, is sufficient to justify the central power station, because it means the installation of less than three-fourths the amount of apparatus in a central station than it would require in separate individual plants for giving the same service.

Even where various services are of the same kind, there is a considerable amount of diversity. Mr. Samuel Insull, in an interesting and instructive paper read before this institute in April, 1912, has shown this to be true. He finds, for instance, that the diversity for the operation of the various steam railroads centering in New York is of the order of some 6 or 8 per cent. When it is borne in mind that this is the diversity for the same kinds of service, it is evident that the diversity between different kinds of service will be very much greater. It is important, therefore, that a central station diversifies its service just as far as possible. For instance, a plant whose main business is to supply lighting and general power can take on a railway load more economically than can a plant whose output is already being taken by railroads. On account of the diversity between these different types of load, the addition of a railway load may be assured by a plant already carrying a general power and lighting load with the addition of less apparatus than required by a separate plant to serve the same load. Concentration of power supply makes for economy in every aspect.

There are two arguments that may, with reason, be urged against the central station method of supply. The first is that the central station requires the addition of a transmitting and distributing system before its customers can be supplied, and the cost, upkeep and losses in this transmitting and distributing system, must be added to the central station to make it comparable with individual customers' plants. This argument is entirely legitimate as far as it goes, but it does not go far enough. The cost and losses of the transmitting and distributing system do not amount to enough to begin to offset the advantages on part of the central station that have been detailed in the preceding paragraphs. It is, of course, possible to imagine a condition where the cost and losses of transmission and distribution make the central station supply more expensive than an isolated plant, but this means that we have gone beyond the proper radius of that station. The advantages (in the matter of cost) of the central station are so great that the utmost addition, on account of transmission and distribution, and still maintain good regulation, are not sufficient to permit isolated plants to compete.

The second argument in favor of the isolated plant is that during the season that heating is required the steam may be used twice—once for power and the exhaust for heating. This is also a legitimate argument so far as it goes, and its complete discussion requires much more space than I have at my disposal here. In general, however, it can be shown that the advantages which accrue to the centralization of a large amount of power at one point will far outweigh the advantage of the isolated plant, even when it is coupled with the heating proposition, as it so often is.

As a result of the foregoing analysis, the writer is of the opinion that there are only two reasons why central stations should not supply all of the electrical service within legitimate reach of their distributing systems. These are, first, because the rate offered by the central station does not bear a suitable relation to the cost of the service to be supplied, and

Second, because the prospective customer has some motive other than the cost of the supply for not taking his service from the central station.

Conditions that Make Ice Plants Possible Central Station Loads

BY T. H. BURCH, JR.

A Discussion of Operation and Economy of Steam Evaporators in Ice Making.

THE ice-making industry is one of interest and importance to central station managements when the refrigerating equipment of new plants is arranged for electrical operation, or when existing plants can be changed so as to become a central station load. The important feature of the load due to an electrically operated ice plant in the South is good load factor during summer and practically all the year when such plants furnish ice and cold storage service. To make electrical operation attractive to the operator of a steam-driven ice plant, the question of a supply of distilled water without the compressor exhaust steam being available must be settled. This is done in an admirable way by the use of steam evaporators, since by means of them any desired quantity of distilled water may be obtained for ice making without the necessity of reboiling and skimming of exhaust steam impregnated with cylinder oil when used from compressors for this purpose. The arrangement and use of evaporators for ice-making purposes and the economy of same were discussed by Mr. Burch before the Southeastern Section of the N. E. L. A. at its last convention, and we present in what follows an abstract of his remarks:

The character of the evaporator equipment which must be offered to meet a given ice-making condition will depend upon many variable factors, such as coal cost, labor cost, space available, minimum power rate, etc. The economy varies with the number of units installed in series. For instance, a boiler, the most elementary evaporator, furnishes with average coal 7 pounds of steam per pound of coal burned. If this boiler steam is passed through the heating coils of an evaporator, which coils are immersed in the water to be distilled, this 7 pounds of boiler steam will be condensed if the water is at a lower temperature than the steam, and the latent heat will pass to this water and approximately 5.95 pounds will be evaporated. This gives a total of 12.95 pounds of distillate per pound of coal from this combination of boiler and evaporator. If the steam generated in the evaporator is again passed into the heating coils of a second evaporator, the process above outlined will be repeated and a further supply of steam obtained. This cycle may be repeated as long as it is possible to obtain a temperature difference between the heating steam in the coils and the water to be evaporated. Commercial practice requires a temperature difference of not less than 30 degrees, so that a reasonable amount of heat may be transferred per unit of heating surface. This minimum temperature difference limits the number of "effects" or evaporators in series to eight operating with boiler steam at 125 pounds and with vapor discharge from the last effect under 24-inch vacuum. Such an equipment will furnish 6 pounds of distilled water for every pound of steam furnished the high pressure evaporator, or from coal to distilled water a maximum of 42 tons of distilled water per ton of coal may be obtained if the boiler is evaporating 7 pounds per 1 pound of fuel.

The justification of converting a steam-drive ice plant to an electrically-driven one will depend, therefore, upon whether or not the following items of cost can be made to balance in favor of the use of current. For the steam-driven plant: Compressor power; circulating pump power; agitators; boiler feed pumps; distilled water pumps and air compressor or electric generator power; excess live steam needed for shortage in exhaust steam needed for ice making, and live steam needed for reboiling.

For the electrically-driven plant: Compressor power; circulating pump power; agitators; electric hoist for cans; coal charge for evaporators; boiler feed pump for boiler and evaporators; and distilled water pump.

No detailed figures for the above items are available at the moment, and the writer will, therefore, develop comparative cost figures for two sizes of ice plants using the following assumption: Coal cost, $3.00 per short ton; boiler evaporation of 7 pounds steam per 1 pound coal; reboiling and skimming losses in steam-driven plant, 33 1/3 per cent; excess for electric drive, 10 per cent.

The comparative operating costs for a 20-ton ice plant, assuming coal at $3.00 short ton, boiler evaporation 7 to 1, and production of 1 ton of ice per 2½ I. H. P. of steam engine driving compressor, are as follows:

A 20-ton steam-driven plant requires 25 tons of steam, which, on the above basis, costs $10.28 per 24 hours. A 20-ton electrically-driven plant with 4-effect evaporator giving 3½ pounds of water to 1 pound of boiler steam requires 22 tons daily or 520 pounds steam hourly, costing $2.68 per day, are required, and power to replace steam units and power for two motor pumps of 868 Kw. hrs. per day. Then to compete, electric power must be furnished to the extent of 868 Kw. hrs. for $10.28 — $2.68 = $7.60, or at the rate of 875 mills per Kw. hr. The approximate cost of plant is $3,000.00.

The comparative operating costs for a 100-ton plant and the same assumptions are: The steam-driven plant needs 133 tons of steam during 24 hours, costing $57.00. For a motor-driven plant using 8-effect evaporators, giving 5½ to 1 or 38½ to 1 from coal, the evaporators must furnish 100 tons of water per 24 hours, requiring 1,660 pounds of steam hourly at a cost of $8.58 for coal. Power for replacing engines, 175 Kw., and power for two extra pumps, 5.6, or 181.6 Kw., representing a load of 4,360 Kw. hrs.

For electric power to compete 4,360 Kw. hrs. must be furnished at $57.00 — $8.58 = $48.82, or at the rate of 1.11c per Kw. hr. Approximate cost of plant, $9,000.00.

These examples are subject to variation after consideration of local conditions for any given plant.

The erection problem is not a new one, as the Knickerbocker Ice Company, of Chicago, have operated several of their plants electrically and obtained the necessary distilled water from evaporators for some years. There are also two large plants in Canada which were installed last winter, and of which recent reports show very successful operation, both as regards cost and quality of ice made. The actual figures of operating cost for the three items which enter largely into the total cost of ice in an electrically-driven distilled water plant of approximately 160 tons capacity are: Coal, 12c per ton; labor, 37c per ton; power, 46c per ton, these figures being the average for a month.

The exponents of raw water ice will heartily endorse any endeavor to electrify steam ice plants, as by so doing the first thought is to adapt the freezing conditions to the use of raw water. Such a policy is very short-sighted. Not only are operating costs for labor higher in a raw than in a distilled water plant, but the market for raw water is gradually diminishing, since raw water is constantly subject to pollution from an infinite number of sources. Freezing does not kill the typhoid germ, while boiling at 212 degrees only destroys the elder members of the family, leaving the "spores" in fit condition to cause illness. Distillation is, therefore, the only method of furnishing ice suitable for use at all seasons and for all purposes, and this fact is so well recognized in many communities that legislation is now pending which will compel the manufacture of distilled water ice wherever ice is used for human consumption.

This outline of the possibility of combining electric motors and multiple effect evaporators for the manufacture of first-class, low-priced artificial ice may serve as a guide to the major points to be considered, but, as emphasized before, the figures are empirical, and each problem must be considered on its merits in order to determine the proper rate at which power must be supplied in order to justify its use.

Comment on Canadian Lighting and Power Situation.

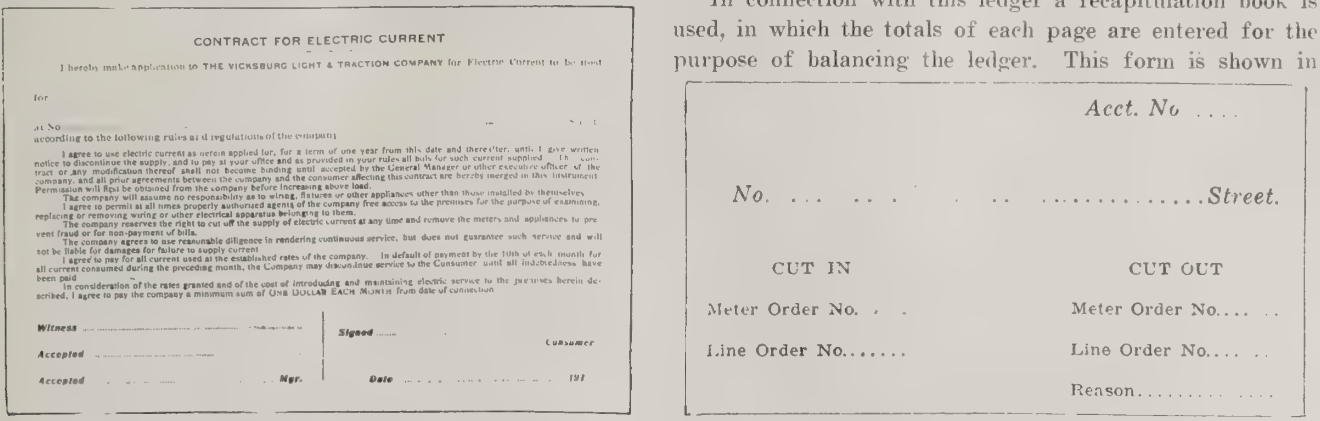
A writer in a recent issue of the daily consulate reports says: "The most significant and far-reaching industrial movement in recent years in Ontario is that undertaken by the Province through its Hydroelectric Power Commission. In addition to the expenditure already made of $5,915,725, the commission is authorized to spend $5,000,000 during the current year in extending the work of furnishing electric energy at cost to municipalities for power and lighting. In addition to the 45 municipalities served last year, more than 100 others have asked for estimates for installing plants for the distribution of electric power to be obtained from the generating works at Niagara Falls and other places. By the end of last year 45 municipalities had installed electric power distributing plants at a total cost of $8,469,197 (of which Toronto expended $3,919,810); the total revenue derived therefrom was $2,605,006 and the net surplus $390,012. It is the policy of the municipalities to retain a part of the revenue as working capital.

"A compilation of the private electrical corporations in Ontario has been carefully made by the Canadian Electrical Association, Toronto, which is a branch of the National Electrical Association of the United States. It has been found that the number of plants is 157 and the total capitalization approximately $108,500,000, which includes the hydroelectric power plants at Niagara Falls. Estimates of cost were made for only a few plants having a capitalization of something more than $1,000,000. Besides the works of the 157 companies there are some hydroelectric and other electric power and lighting plants owned by municipalities."

Accounting System Used by the Vicksburg Light and Traction Company

BY L. W. WADE, CHIEF CLERK.

THE subject of central station accounting has been much discussed and investigated by public service commissions, with the result that definite efficiency principles have been made known which not alone save time and labor, but present the details of the business in a manner that makes such readily accessible and easily understood. An interesting and simple accounting system for a small central station company was explained by Mr. L. W. Wade at the recent convention of the Mississippi Electric Association. This system is in use by the Vicksburg Light & Traction Company and described in what follows:



CONTRACT FOR ELECTRIC CURRENT

I hereby make application to THE VICKSBURG LIGHT & TRACTION COMPANY for Electric Current to be used

for

at No

according to the following rules and regulations of the company

I agree to use electric current as herein applied for, for a term of one year from this date and thereafter, until I give written notice to discontinue the supply, and to pay at your office and as provided in your rules all bills for such current supplied. The contract or any modification thereof shall not become binding until accepted by the General Manager or other executive officer of the company, and all prior agreements between the company and the consumer affecting this contract are hereby merged in this instrument. Permission will first be obtained from the company before increasing above load.

The company will assume no responsibility as to wiring, fixtures or other appliances other than those installed by themselves.

I agree to permit at all times properly authorized agents of the company free access to the premises for the purpose of examining, replacing or removing wiring or other electrical apparatus belonging to them.

The company reserves the right to cut off the supply of electric current at any time and remove the meters and appliances to prevent fraud or for non-payment of bills.

The company agrees to use reasonable diligence in rendering continuous service, but does not guarantee such service and will not be liable for damages for failure to supply current.

I agree to pay for all current used at the established rates of the company. In default of payment by the 10th of each month for all current consumed during the preceding month, the Company may discontinue service to the Consumer until all indebtedness have been paid.

In consideration of the rates granted and of the cost of introducing and maintaining electric service to the premises herein described, I agree to pay the company a minimum sum of ONE DOLLAR EACH MONTH from date of connection.

Witness ....

Accepted ....

Accepted .... Mgr.

Signed ....
Consumer

Date 191

Acct. No ....

No. .... Street.

CUT IN
Meter Order No. ....
Line Order No.......

CUT OUT
Meter Order No.......
Line Order No.......
Reason.............

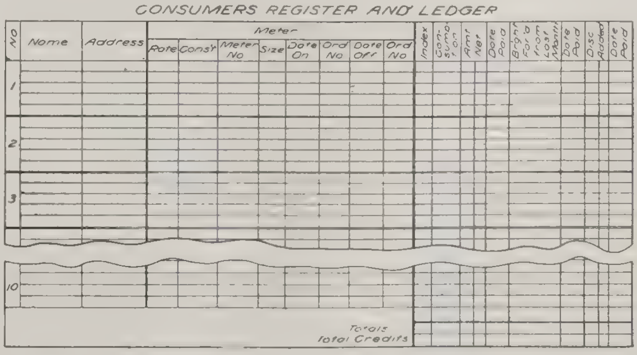
FIG. 1. FORM OF CONTRACT CARD, 4 BY 6 INCHES, AND BACK OF SAME.

The consumer must first make application for service. A card is used for this purpose, the convenient size for which being 4 x 6 inches. On one side of the card are the terms of the contract, below which are lines for signature of applicant and date of application; also line for signature of manager or other officer of company approving the credit. On the other side of this card, at the top, is written the consumer's name, address and account number. Below this are spaces for keeping a record of the cut-in and cut-out under order numbers. This card is shown in Fig. 1. These cards, when properly filed, form a card index to the consumer's ledger. After application card has been signed and approved for credit, cut-in orders issued and executed, the account is opened in consumer's ledger. The account number is then written in a space provided for this purpose on the card, and the card filed in a subdivision alphabetical index, where it is kept for the purpose of finding the consumer's account number. When service is ordered discontinued, this card is taken from file. The file, therefore, contains no dead contracts. This does away with the old style of book index, which requires a great deal of time to re-write each year, and which always carries dead names.

We will next take the "electric ledger," which is loose leaf and made up of three sheets to each ten accounts, as shown in Figs. 2 and 3, with one long sheet and two short sheets. The long sheet contains the consumer's account number, name, address, rate, constant of meter, meter number and size, date cut-in, etc., and has ten accounts to a page, each account having five lines. This sheet will last indefinitely, and, if it becomes full, is immediately replaced by a new sheet. It is, therefore, unnecessary to transfer the entire ledger at the end of each year, as must be done when a bound ledger is used. The two short sheets contain spaces for twelve months' accounts, each sheet having spaces for three months' accounts to the page. Each of these spaces is divided in columns, as follows: Meter readings; consumption; net charges; date of payment; amount brought forward; date of payment; discount added; and date of payment.

In connection with this ledger a recapitulation book is used, in which the totals of each page are entered for the purpose of balancing the ledger. This form is shown in Fig. 4. The ruling of this book is similar to that of the short ledger sheet, having additional columns provided for debtor balance, credit balance, journal entries, and interim collections. This book will show the total amount of current sold to consumers; the total charges for same; the total uncollected from previous month; the total collected during the month; and the total to be carried forward to the next month. By using this book the ledger is easily balanced at the end of the month. If an error has been made, it is much easier to correct than when the totals are carried from one page to the next through the ledger.

Going back to the ledger, on the first of the month the consumption and charges for the previous month having been entered in ledger and the balances brought forward from previous month, each page is totaled and the totals entered in the "recapitulation book." After the month's



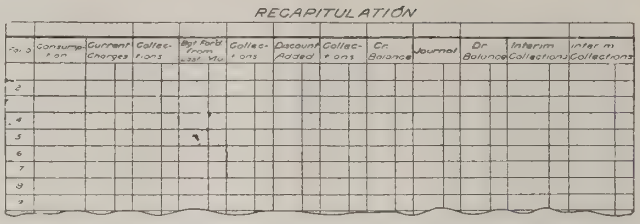
CONSUMERS REGISTER AND LEDGER

No	Name	Address	Meter								Index	Consumption	Amt	Net	Date Paid	Brght Forward from Last Month	Date Paid	Disc	Added	Date Paid
			Rate	Const	Meter No	Size	Date On	Ord No	Date Off	Ord No										
1																				
2																				
3																				
10																				
Totals																				
Total Credits																				

FIGS. 2 AND 3. FORMS FOR THE CONSUMER'S LEDGER.

accounts are closed, collections made on previous month's bills are totaled on each page, and totals are entered in "recapitulation book" opposite charges for that month. The "recapitulation book" is then added and ledger is balanced.

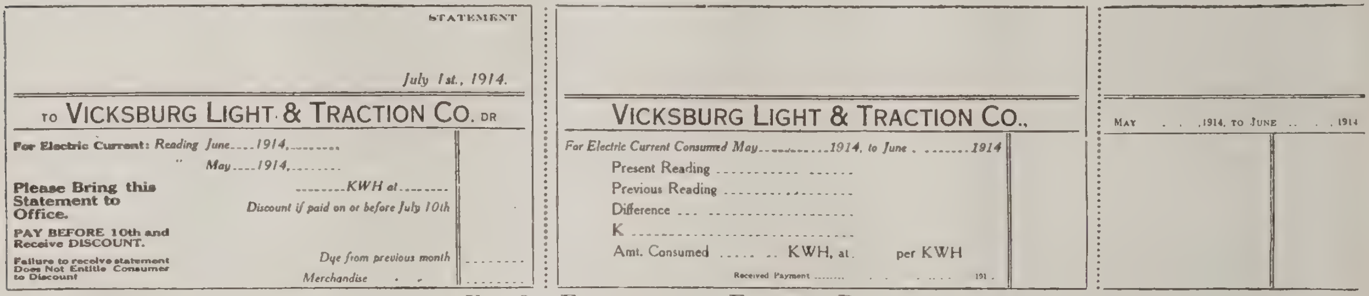
After the consumer's account is opened in the ledger, a meter slip is made out and put in meter reader's book, as shown in Fig. 5. This sheet should be of such size as to allow book to fit in the coat pocket. At the top of the sheet are spaces for consumer's account number, name and address, location of meter, and meter number and size. The lower part of sheet is divided in spaces for three years' readings. On the left margin is printed the twelve months of the year, beginning at the bottom of sheet with January. By arranging the months in this manner the present reading is always above the previous reading.



RECAPITULATION

Folio	Consumption	Current Charges	Collections	Bal Ford from Last Mo	Collections	Discount Added	Collections	Cr. Balance	Journal	Dr Balance	Interim Collections	Interim Collections
2												
4												
5												
6												
7												
9												

Fig. 4. Form for Recapitulation Book Used With Ledger.



STATEMENT

July 1st., 1914.

TO VICKSBURG LIGHT & TRACTION CO. DR

For Electric Current: Reading June....1914,........

" May....1914,........

........KWH at........

Discount if paid on or before July 10th

Dye from previous month ....

Merchandise ....

Please Bring this Statement to Office.

PAY BEFORE 10th and Receive DISCOUNT.

Failure to receive statement Does Not Entitle Consumer to Discount

VICKSBURG LIGHT & TRACTION CO.,

For Electric Current Consumed May..........1914, to June 1914

Present Reading ....

Previous Reading ....

Difference ....

K ....

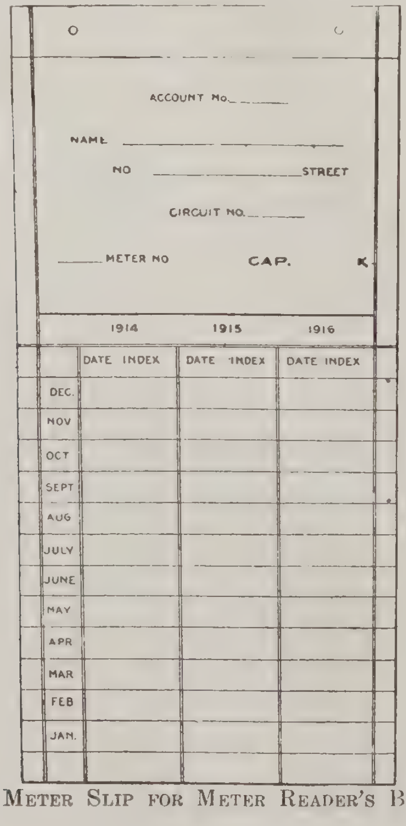
Amt. Consumed .... KWH, at per KWH

Received Payment .... 191 .

May ....1914, to June 1914

Fig. 6. Form for the Electric Bill.

We will now take up the electric bill, which is shown in Fig. 6. This bill is in three sections—the statement, the receipt, and the cashier's stub—perforated between each section, and designed to be addressed with an addressing machine. It is especially adapted to plants doing a merchandise business. The size of the bill is 3½ inches by 14½ inches. The statement and receipt are each 6 inches in length and very similar; the statement, however, is provided with spaces for balance due from previous month and amount due for merchandise. The consumer's account number, name and address are printed by the addressing machine at the top of each section of bill, the bills coming from the machine in the same order as the accounts run in the ledger. After the bills are addressed, the previous reading and date are copied on them from ledger. This should be done before the meter reader starts. As the new readings come in they are copied on the bill and subtractions made. The bill is then calculated and copied in the ledger. Companies giving a discount for prompt payment of bills will find quite a saving of time and labor by using a set of calculating stamps in making out bills. By using an addressing machine and the calculating stamps in con-



ACCOUNT NO.____

NAME ________

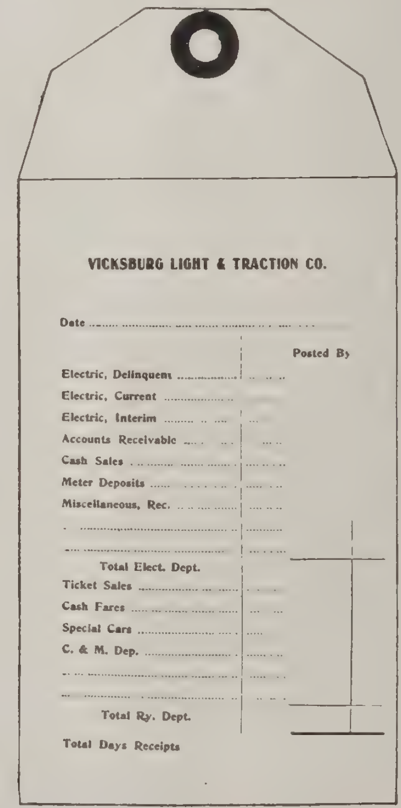
NO ________ STREET

CIRCUIT NO.____

____ METER NO CAP. K

	1914		1915		1916	
	DATE	INDEX	DATE	INDEX	DATE	INDEX
DEC.						
NOV						
OCT						
SEPT						
AUG						
JULY						
JUNE						
MAY						
APR						
MAR						
FEB						
JAN.						

Fig. 5. Meter Slip for Meter Reader's Book.



VICKSBURG LIGHT & TRACTION CO.

Date ....

Posted By

Electric, Delinquent ....

Electric, Current ....

Electric, Interim ....

Accounts Receivable ....

Cash Sales ....

Meter Deposits ....

Miscellaneous, Rec. ....

Total Elect. Dept.

Ticket Sales ....

Cash Fares ....

Special Cars ....

C. & M. Dep. ....

Total Ry. Dept.

Total Days Receipts

Fig. 7. Clasp Envelope Used to File Cashier's Bill Stubs Each Day.

nection with this form of bill, it is possible for one person to make out and enter in ledger from twelve to fifteen hundred bills in three days. After bills are made out the merchandise bills are pinned to them, and statements are torn off and sent out. The rest of the bill is filed in numerical order in a cabinet provided for that purpose, which is kept near the cashier's window. This cabinet is divided into pigeonholes, which are numbered by hundreds, each pigeonhole holding one hundred bills. When filed in this manner, bills are easily located when the consumer calls to pay them.

The last steps in handling the consumer's accounts are making the collection and posting to cash book and ledger. At the end of the day the cashier's stubs are sorted and arranged in numerical order, and listed on an adding machine, a total being made of each class of collection. This adding machine list is then wrapped around the stubs, and both are filed in a special clasp envelope, shown in Fig. 7. This envelope is sufficiently large to hold the stubs of an ordinary day's business. The date and the total of each class of collections are written on the face of the envelope. These totals are then copied to the cash book. Posting to the ledger is done from the cashier's stubs, which have been arranged in numerical order. After posting is done the stubs are fastened together with a paper fastener and filed away for future reference. This system does away with the antiquated method of entering each individual collection in the cash book, and it is much easier to post from the cashier's stub than from the cash book.

Characteristics of Induction Motors without Starting Devices

BY F. R. BELL.

ONE of the greatest drawbacks that the squirrel cage induction motor has experienced as regards application, is the requirement of special apparatus or wiring for starting. This type of motor when connected to full line voltage may be considered in principle of design a transformer with a short-circuited secondary. The direct application of full line pressure to the stator or primary winding with the rotor short-circuited and at rest thus causes a large inrush of current in the stator winding as would be the case in the primary of a transformer under such conditions. In the usual design of induction motor this current inrush may be as much or more than five times the rated value at the full load and is sure to injure the winding insulation if the inrush is permitted to take place every time the motor is started. Further, the underwriters' rules and motor circuit wiring make it imperative that this current rush be limited. Again the power factor of the starting current of an induction motor is low, about 30 to 40 per cent, thus on account of the effect on line regulation and to avoid voltage fluctuation, even induction motors of moderate size require starting apparatus in the primary circuit which is usually of such a nature as to enable the motor to start on reduced line voltage.

To get around the need of starting apparatus, one motor manufacturer has produced an induction motor with the stator windings so arranged that by using a properly wired double throw switch, these windings can be connected in Y for starting and delta for running. When this scheme is used the voltage per phase at starting is $(1 \div \sqrt{3})$ or 58 per cent of the line voltage, so that the starting current is about one-third that when the motor is thrown directly on the line with the stator delta connected, or about 1½ times full load current. Since the starting torque is proportional to the square of the potential difference used by the above connections, it follows that the torque of such a motor at starting, using the star-delta starting scheme, is about one-third that when starting with full line voltage. This reduction in starting torque is therefore one of the limitations of this scheme.

In what follows a brief discussion will be presented to explain the design and operation of a polyphase motor re-

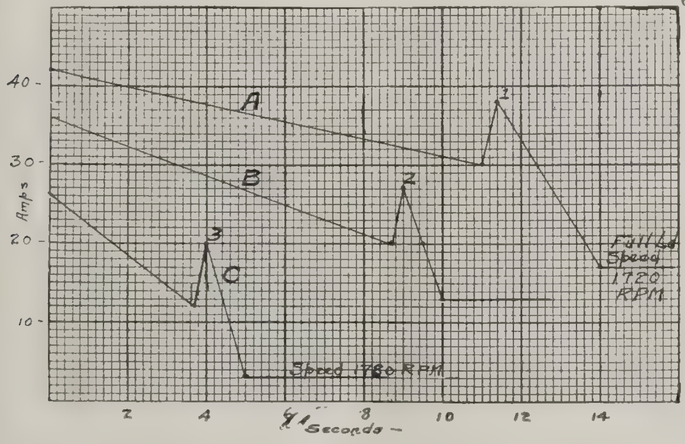


FIG. 1. STARTING CHARACTERISTICS FOR A 15 HORSEPOWER COMPENSATED MOTOR. CURVE A STARTING FULL LOAD, CURVE B AT 0.75 LOAD AND CURVE C AT NO LOAD. POINTS 1, 2 AND 3 SHOW WOUND ROTOR SHORT CIRCUITED.

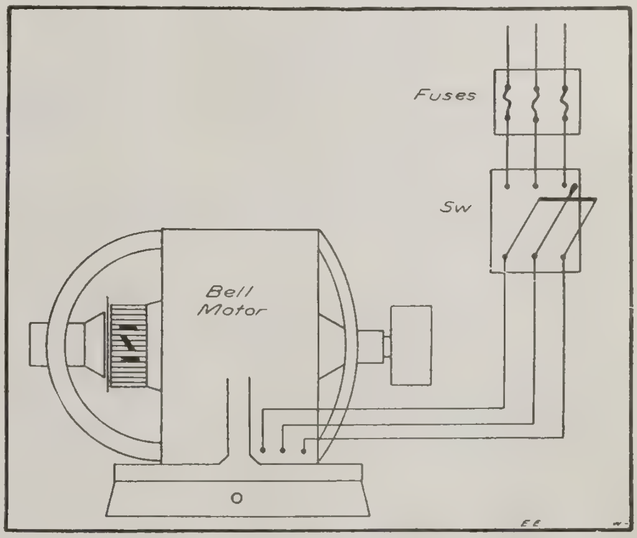


FIG. 2. CIRCUIT CONNECTIONS NECESSARY FOR A COMPENSATED MOTOR.

cently designed that requires no starting apparatus for what has usually been considered large sizes of induction motors, in fact, the design makes possible the starting of motors as large as 40 horsepower directly on full-line voltage, without blowing of fuses, use of special fuses, or external resistance and with a power factor at starting under full load ranging from 80 to 85 per cent. This operation is made possible by the use of a so-called compensated rotor which is made up of two independent windings, namely, a high resistance squirrel cage winding used to bring the motor up to speed and an extra high resistance coil winding under the squirrel cage winding with the coil terminals connected to a commutator. When the rotor attains nearly full speed the commutator is short-circuited and the motor operates with low internal resistance, high efficiency and small slip. The squirrel cage winding is very light and so proportioned as to bring the motor up to speed on full load with about twice full load current. Arrangements are provided for increasing the starting torque when necessary through short circuiting the commutator segments by means of copper clips as shown in Fig. 4. This adds more copper to the rotor at starting and gives more starting torque in proportion. Through the use of the two windings on the rotor, a double transformation takes place, which reacts upon the stator winding in such a way as to raise the power factor of the motor, as already stated.

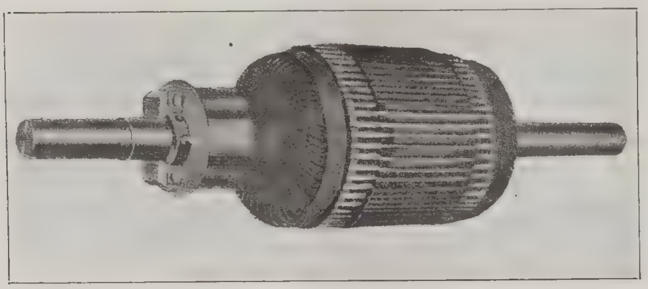


Fig. 3. The Rotor for a 3-Phase Compensated Motor.

The starting current for this design of alternating current motor varies from two to two-and-a-half times full load running current. The motor starts under full load, thus making it a most satisfactory machine for remote control and for driving pumps and elevating machinery. In Fig. 1 the starting characteristics of a 15 horsepower compensated motor are shown when starting at no load .75 and full load. It is here shown that the full load starting current is 42 amperes and running current 17 amperes, or that the starting current is about 2.4 times full load current. In Fig. 2 the required connections for this type of motor are shown, while in Fig. 5, the characteristics shown from actual tests on a 10-horsepower, two-phase, 220-volt compensated motor are shown.

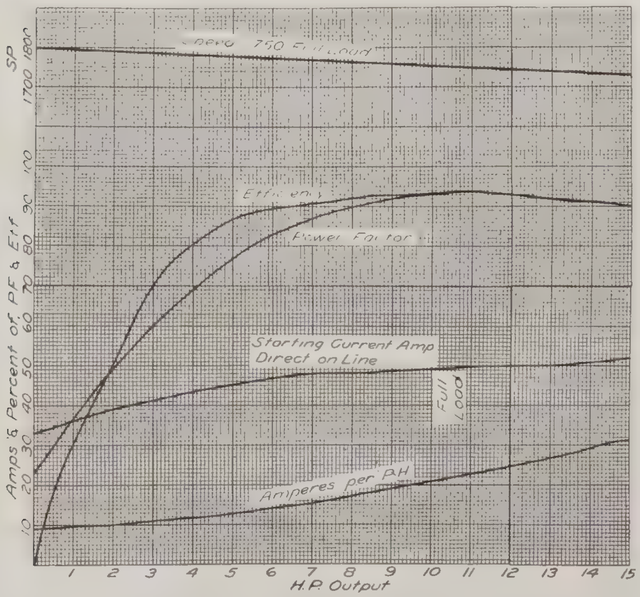


Fig. 5. Starting Current, Power Factor, and Efficiency of a 10 Horsepower, Two-Phase, 2200 Volt Compensated Motor.

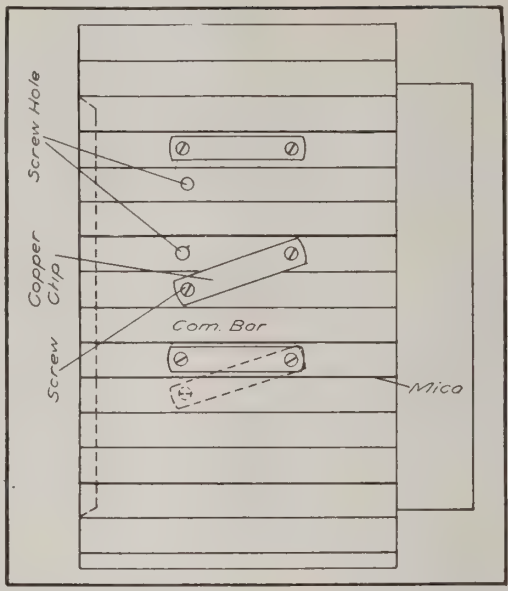


Fig. 4. Arrangement for Increasing Starting Torque of Compensated Motor.

Detroit Convention of National Electrical Contractors' Association.

The 14th annual convention of the National Electrical Contractors' Association was held at Detroit, Mich., July 14 to 18, attended by some 700 contractors, jobbers, manufacturers and guests. The sessions were held at Hotel Cadillac.

The convention was formally opened on Wednesday morning, the 15th, at 10 o'clock by addresses of welcome by Past President Ernest McCleary, of Detroit, and Police Commissioner John Gillespie. These addresses were appropriately responded to by Ernest Freeman, president of the association. During his remarks Mr. Freeman said that business in the electrical construction field is good and improving. He outlined the work of the association and pointed out the progress made during the year.

Following President Freeman, John Trix, of Detroit, vice-president of National Association of Manufacturers, gave a talk urging the necessity of studying the costs of doing business. He said that often the wise contractor is the one who refuses to bid on every job. He urged the contractors to patronize American manufacturers whenever possible.

W. N. Mathews, Jupiter of Jovian Order, next spoke on the work of the order and the benefits of co-operation.

Hon. J. E. Kinnane next spoke on work of Michigan Industrial Accident Board, stating that 95 per cent of the Michigan manufacturers have entered into the movement and are securing a low rate for carrying liability in accordance with the methods and preventative measures adopted to protect and safeguard employes against accident. In case of accident the employe receives one-half wages.

At the close of the Wednesday morning session a handsome cut-glass water set was presented to Past President Ernest McCleary as a gift of the Detroit contractors. At this session also, an expensive ivory gavel was presented to President Freeman on behalf of the Michigan Contractors' Association.

At the Wednesday afternoon business session of the contractors' association, T. I. Jones, of the commercial section, National Electric Light Association, discussed business conditions, declaring that the development of electrical uses had caused the trade far to exceed normal prosperity.

Thursday was devoted to business by the contractor's association and the sessions closed except to member contractors. During the afternoon session, S. E. Doane, chief engineer of the National Lamp Works of the General Electric Company, spoke on "Observations of Central Stations and Contracting Conditions in Foreign Countries."

On Wednesday night, the Jovians held a rejuvenation and took in about 30 members. The Detroit degree team had charge of the rejuvenation and carried out all details in an able manner. A street parade created considerable local interest.

The entertainment features were well arranged and thoroughly enjoyed by all. A theater party, automobile ride, and boat trips made up this part of the program.

At the executive meeting on Thursday, the following officers were elected:

President, John R. Galloway, Washington, D. C., formerly treasurer; first vice-president, J. C. Hatzel, New York City; second vice-president, W. L. Hutchinson, Kansas City, Mo.; third vice-president, John C. Rendler, Loe Angeles, Cal.; treasurer, James Hilton, Syracuse, N. Y.; secretary, George H. Duffield, Utica, N. Y.; sergeant-at-arms, J. C. Sterns, Buffalo, N. Y. The vice-presidents, secretary and sergeant-at-arms were re-elected.

San Francisco was chosen for the place of meeting in 1915, and New York won the 1916 convention after a hot contest with New Orleans. The Crescent City withdrew on a promise of the 1917 meeting.

In accepting office, President-elect Galloway, for the association, presented to retiring President Ernest Freeman, of Chicago, a heavy gold watch fob emblem of the association. Such emblems will hereafter be presented to each retiring president.

Electrical Projects in Japan.

According to Consul General Thomas Sammons, of Yokohama, there has been a remarkable advance in the manufacture of electrical appliances in Japan. At first, he says, the electrical business was confined to providing light and power for electric street car lines, but now the electrical manufacturing companies in Japan are becoming very prominent as well as good dividend payers in many instances. Two companies of the latter class that attract much attention are the Shibaura Engineering Works, at Tokyo, and the Tokyo Electric Company (Ltd.), having extensive and up-to-date electric lamp manufacturing factories at Kawasaki, located on the steam and electric railway lines, between Tokyo and Yokohama. The General Electric Company of the United States owns 51 per cent of the lamp works and nearly a one-third interest in the Shibaura plant, which has a paid-up capital of $1,187,000. The lamp company's capital is now $1,300,000.

The lamp plant is credited with turning out the great bulk of all the electric lamps used in Japan, while the Shibaura works manufacture machinery up to from 3,000 to 4,000 kilowatt size in generators, transformers, motors, etc. Notwithstanding this, about 80 per cent of all-electric motors are still imported, including those of from 500 to 1,000 kilowatt power.

The business of furnishing electric power for manufacturing plants in Japan is also comparatively new, power plants for the operation of electric railways and furnishing electric light having appeared first. It is now roughly estimated that the electrical plants of all kinds in Japan represent about $280,000,000, including capital stock. Ten years ago the electrical properties of Japan were estimated to represent only about $14,000,000. During the above period the kilowatt power produced in Japan advanced from less than 45,000 to over 345,000, the number of miles of electric wire from less than 10,000 to over 35,000, and electric railway mileage from less than 100 to over 700.

Program for Convention of Southeastern Section N. E. L. A. at Isle of Palms.

The convention of the Southeastern Section of the N. E. L. A., to be held at the Isle of Palms, near Charleston, S. C., on the 19, 20 and 21 of the present month, promises to be interesting from many standpoints as shown by the following program.

Wednesday morning, August 19, will be given over to registration. The first session will be called at 2:00 P. M. and opened with an address of welcome by Hon. John P. Grace, mayor of Charleston, S. C. This address will be followed by the address of the President, T. W. Peters, of Columbus, Ga. The papers scheduled for this session are as follows: The Central Station's Greatest Opportunity—The Electric Vehicle, by A. L. Dixon and F. Nelson Carle of General Vehicle Company, Long Island City, N. Y. Commercializing Electrical Advertising by Normal B. Hickox, manager of the Greenwood Advertising Company, Knoxville, Tenn.

On Thursday morning, the 20th, the second session calls for three papers: Telephone Communication in Relation to High Tension Distribution, by E. S. Moorer of Western Electric Company; Feeder Voltage Regulation by A. D. Fishel of the Westinghouse Electric and Mfg. Company; and Recent Developments in Incandescent Lamps by T. W. Moore and Henry Schroeder of General Electric Company.

On Thursday afternoon, an excursion by boat is scheduled to visit Fort Sumpter and the Navy Yard. In the evening at 8:00 P. M. the third session will be held and a paper on How, When and Where, or a Few Irregular Thoughts on Regulation read by J. S. Bleeker, of the Columbus Power Company, Columbus, Ga. The report of the public policy committee will also be presented at this time by P. S. Arkwright, president of the Georgia Railway and Power Company, Atlanta, Ga.

On Friday morning, the final general session provides for an address on N. E. L. A. activities by an officer of the National body. Also a paper on Selling Current to Municipalities by Wm. Rawson Collier of the Georgia Railway and Power Company, Atlanta, Ga. This session will be closed with a new feature, known as an "experience meeting" which will provide an opportunity for an open discussion on any topic of interest to those present.

The afternoon on Friday will be devoted to an executive session during which the election of officers will take place.

New Business Methods and Results

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

The Central Station and the Electric Vehicle.

It has been about 15 or 20 years since the self-propelled vehicle or the "horseless carriage" as it was first termed, began to be of commercial importance in this country. Since that time the industry has grown by leaps and bounds. The president of the Electrical Vehicle Association of America at the last convention, gave the total number of electric vehicles in the country as 37,000, of which 25,000 are pleasure cars, and 12,000 are trucks. In Chicago there are over three thousand, in New York City over two thousand, in Cleveland the same number, while Denver, Boston and Washington have about one thousand each. In addition, we find electricity used for fire engines, ambulances, patrol wagons, baggage trucks, transfer trucks for dock and warehouse use, and in other places where it is the only suitable motive power.

The development of two features, speed and mileage, has brought the electric car to the point where except for unusual requirements, it may fairly be said to be a competitor of the gasoline car and it now only rests with the central stations in the smaller towns to provide charging facilities and thus open up the country to the "electric" tourist.

The mileage has been increased from strictly a short-haul proposition, until now a car can cover on one charge about all the distance usually required for one days run. With boosts at noon, from 150 to 175 miles can be easily accomplished. For trucking, one charge will perform one full day's work. The speed of trucks is from 10 to 12 miles per hour, and for pleasure cars an average of from 20 to 25 miles for runs covering several hours. This is as fast as should be undertaken with safety.

The question of touring by electric automobile has received much attention. In a recent paper, "Touring by Electric Automobile," by Col. Bailey of S. R. Bailey and Co., some figures of remarkable runs are given. Last summer a trip of between 500 and 600 miles was taken over rough, hilly and sandy roads in Vermont and New Hampshire without difficulty. A trip from Boston to Burlington, Vt., of 258 miles, was made at an average speed of 19 miles per hour. There is also a list of various daily runs made through the New England states, varying from 103 miles down to 22 miles. Each of these was made with one charge of battery. The average speed was from 18.4 to 26 miles per hour. Mr. Bailey also gives figures for a trip from Boston to Chicago, from Oct. 14 to Oct. 31, 1913, in the face of bad roads, bad weather and inadequate charging facilities. During 5 days of this trip over 100 miles per day were made, the highest record being from Syracuse to Buffalo, N. Y., a distance of 173.5 miles. The total distance was 1,305 miles, the average speed for the trip 15.6 miles per hour and the current consumption 3.14 amp. hours per mile, which if taken from 110 volt circuits would equal 345 watt-hours per mile. On one day after very heavy rains he covered 85 miles, of which 61 were over roads reported impracticable. After passing two gas cars stalled in the road he got stuck himself but was out again in 45 minutes under his own power.

The cost of operation of pleasure cars varies quite a little in different parts of the country. In New York City the charge for washing, polishing and current varies from $35.00 to $55.00; without current from $20.00 to $25.00, with current extra at from 5 to 10 cents per Kw.-hr. For cars charged in private garages over the country, the cost of current varies from 5 to 10 cents, the lower figure prevailing. In some cities a 4 cent rate is given, and in Denver a 10% discount. A study of the conditions at large would indicate that the average cost of garaging including current is about $23.50 per month. The cost of current only when purchased from private garages averages $5.73 per month and tire renewals $2.78.

The electric truck cannot be operated at its full efficiency unless given plenty of work to do. It costs more to operate one motor truck than a pair of horses if the truck does only the work done by the horses. A saving can be shown however, when the routes are re-arranged so that the largest size truck can be filled and completely emptied over a route taking a full day for one driver. One motor truck can and should often be able to replace from two to four horse drawn wagons.

Besides heavy trucking the light delivery wagon is coming into extensive use. Several large stores have from 22 to 80 of these electric wagons. The 1,000 pound car which is usually used for city parcel delivery shows by test a cost of 25 cents per mile as against 27 cents with horse delivery, but the electric car in this test made 198 deliveries per day as against 144, and hence the cost per delivery was reduced from 4.5 to 4.2 cents. For suburban delivery the reduction was greater, being from 8.5 to 6.7 cents. Since the electric car could make 365,000 deliveries per year, the saving was $550. A notable installation is that of Gimbel Bros., in New York, where 83 electric and 43 gasoline delivery wagons are used. The electric cars use batteries of 44 lead and 60 Edison cells. The system for taking care of these cars, keeping records of their condition and operation and making repairs, is probably the best that is in use by any commercial establishment. In the Xmas rush of last December every one of these electric cars were in service the entire month without a breakdown. The electric truck is also coming into use for parcel post service. The New York Post Office operates 12 of these, which last December gave a total of nearly 7,000 miles and delivered nearly one million parcels.

Besides the greater efficiency of the electric vehicle itself, there is a distinct advantage associated with the higher speed. "The horse," says Mr. Hayden Eames, "is a slow moving animal and the driver naturally regulates his gait accordingly. The higher speed of the electric stimulates more efficient action all around. The driver moves quicker, the loading is accomplished sooner, and there is an incentive for the provision of better terminal facilities, improvements in routing, etc. It has been shown that in the case of the horse drawn delivery that the team stands idle one-third of the total time, while with the electric wagon this can be reduced to 22 per cent.

As to the cost of truck operation, below are given two sets of figures showing operation cost in cents per mile for different sizes of wagons. Column "A" shows results given by the Commonwealth Edison Company. The figures in Column "B" were computed by Mr. Wm. P. Kennedy from manufacturers' information and other sources.

SIZE TRUCK	CENTS PER MILE A	B
700 pounds	6.30	5.54
1,000 pounds	6.85	6.18
2,000 pounds	7.66	7.34
3,000 pounds		8.17
4,000 pounds	8.85	8.98
7,000 pounds	10.38	10.88
10,000 pounds	11.60	12.32

From the above we can readily see the advantages of using the largest size of trucks.

We will now consider the logical part that the central station should take in the development of the industry. The electric vehicle certainly cannot get along without the central station and the central station needs the vehicle load. It is therefore very much to the advantage of both that a plan of co-operation be arranged. This is a fruitful field of disagreement between the truck manufacturers and the central station managers. The manufacturer claims that the central station takes little or no interest in the matter, and will not help to make sales, while the manager claims that he is doing all that he should be expected to do, and that the manufacturers are indifferent as to the service given after sales are made. As a matter of fact, the truth lies between. A number of central stations in the East are co-operating to the fullest extent and boosting the sales of electric trucks in every way. There are others that would if they knew how, and there are some that are yet quite indifferent.

It is evident, the writer believes, that the central station manager should not be expected to sell vehicles. The manufacturer should do this. It is also hardly to be expected that the local company will maintain a technically trained staff as familiar with the product as the manufacturers' own representatives.

The central station is naturally most interested in the sale of current, while the manufacturer is most concerned with the sale of its product. This it seems should afford a very simple basis for the division of labor. If the central station can provide a favorable current rate, see that every user has ample charging and garaging facilities, furnish all information necessary to get good service from a truck or car, watch for prospects and report them to the manufacturer, and assist prospective purchasers in making a suitable selection, it would seem that the central station can readily handle its part. The manufacturer's part is then to act promptly on all information given, sell the vehicle, and stand back of it. Such a co-operation should bring good business to all.

Every central station that takes up the electric vehicle business is at once confronted with the necessity of choosing between actively engaging in the business, selling cars, providing garage facilities, etc., or simply acting in an advisory capacity. It seems that this is in a way a parallel case with the carrying on of wiring propositions, and the sale of appliances. It has been found that the central station has been called upon to do this work at the outset of a business, when suitable persons to carry on such business or to properly inaugurate a campaign, or to insure fair prices and service were not to be found, but in general such work need not be undertaken if a local specialist is willing to put effective effort into it. The electric vehicle is a new proposition in many places and the central station if called upon to start it, must see that it is started right.

SPECIAL USES OF TRUCKS.

The possibilities for making good use of vehicles by the central station are many. Electric trucks have advantages for some advertising purposes. The United Electric Light and Power Company of New York has used a one-ton truck chassis to make an outdoor demonstration of a vacuum cleaner in connection with a special offer. The cleaner was shown in operation, being connected with the battery.

Another similar scheme was used in the early summer with a load of fans, attractively placed on an electric truck, and all connected and running. Naturally the effect was greater than a display with the fans at rest.

Electric trucks are now used to carry cotton from the compressors to the piers at Galveston, Tex. A special 6-ton truck is used with a framework arranged as a pack saddle. Rows of cotton bales are arranged along the sides. The capacity is 30 bales, and the usual load is 9 tons, instead of six. Three of these trucks are used, with 7 more on order.

One of the latest vehicle productions is an electric sprinkler. This has a 1,200 gallon tank with the water delivered under air pressure.

Dean Raymond of the Armour Institute of Technology has announced that his school is to establish courses in the care and operation of electric vehicles. The course will be practical rather than technical, with what technical information is given strictly accurate. The history and development of motor traction will be given, followed by a study of the motor controller and battery, charging methods, rules in driving, and methods of cost keeping.

A Baltimore bargain house began to use power wagons in 1906. It now has 16 electric trucks, including eleven 5-ton, two 3½-ton, and one 2-ton. These trucks all employ a movable body, which is quickly hoisted on or off the truck. While the truck is moving one load, another one can be prepared for it, so that when it runs into the warehouse only two or three minutes are required to lift the empty body off and place the loaded one on. Thus much valuable time is saved. The less idle time spent by an expensive piece of machinery, the greater will be the efficiency and hence it is not surprising to know that this company has reduced its hauling expenses 50 per cent.

As an example of what can be done with electric vehicles in a small town, we refer to Rockford, Ill. With a population of 45,000, it can boast of over 200 vehicles, mostly pleasure cars. This success is largely due to a capable battery man, who takes pains to see that every car is working under the very best of conditions. Naturally this has made well satisfied customers and a corresponding growth of business. A battery life of from 2 to 3 years is regularly secured in this town. The charging rates are 6 cents at private and 4 cents at public garages, with the stipulation that current shall be resold to consumers for 6 cents. There are about 100 private garages in Rockford, where the majority of the machines are kept. The current is sold on off peak contract, to encourage night charging. A fair figure for the annual expense of keeping a pleasure car in Rockford may be given as follows: Current, $60.00 battery upkeep, $30.00; tire repairs, $40.00; vehicle upkeep (mechanical parts), $50.00, which makes a total of $180.00 per year or $15.00 per month. This includes repainting and overhauling.

A. G. Rakestraw.

E. M. Jackson, Electric Vehicle and Storage Battery Engineer, Denver Gas and Electric Light Co., Denver, Colo., Comments on Vehicle Situation in Denver.

Three years ago the Denver Gas and Electric Light Company created a department of electric vehicle and storage battery engineering and engaged a competent vehicle and battery engineer as the head. The primary duty of this engineer was to create a demand for the electric truck in view of the fact that the electric passenger cars were well represented by local agents. At that time there were no electric truck agencies in Denver. Another duty assigned to the engineer was the responsibility of assisting and regulating the public garages; also attending to the contracting and adjustments incident to the battery charging work. This department makes free inspections of all electric vehicles and batteries for the benefit of the owners, and in short, does everything possible to obtain the performance from the vehicles known to be possible.

Co-operating with the electric vehicle engineer are the thirty representatives of the commercial department, who advocate the use of the electric vehicle in their respective territories and who in turn visit with the engineer any favorable prospects encountered in their work of solicitation. There was installed in the City of Denver during the year 1913, 18 electric trucks varying in capacity from 750 pounds to 6 tons.

The vehicle department has advocated the use of rectifiers in the owners' private garages, the rates for the same being $5 per month net minimum when used "off peak" and $7.50 minimum on the "peak," the current consumed being charged for at the rate of 4 cents per Kw.-hr., subject to a discount of 10 per cent. The off peak minimum on a 40 ampere tube is $7.50 net—on peak, $10; the minimum of a 50 ampere tube being $10 net off peak and $12.50 on peak, the current in both of these instances being at the rate of 4 cents per Kw.-hr., with a discount of 10 per cent for prompt payment. At the present time we have 60 electric trucks and about 950 electric passeengr cars in the City of Denver.

C. E. Michel, Manager Electric Vehicle Advisory Dept., Union Electric Light & Power Company, Comments on Electric Vehicle Stiuation at St. Louis, Mo.

In the past the Union Electric Light & Power Company has been very actively interested in the electric vehicle business, but has now given up active work in accordance with avowed intentions at the time the field was originally entered.

"When we first took up this work in 1907," says Mr. Michel, "an electric pleasure garage was operated that was perfect in its appointments. We also took the agency for a well-known car and diligently prosecuted the sale thereof. There was only about ten cars in S.t Louis at htat time as against more than 500 cars when we closed the garage to the public on January 1, 1913, one-fourth of which number were sold by our company.

"In 1912 we opened an electric truck garage which was also a model of its kind and took the agency for a well-known truck. We had fairly good sucess in this field until 1913, when we were obliged to close this garage to the public and use it exclusively for our own use. There are about 175 trucks now in operation in St. Louis, which number is not one-tenth of what there should be, and we are now doing all we can to promote and liven up the electric truck business. We are, however, doing this from the outside.

"The true facts are that nowhere in the United States are electric trucks being sold in quantities warranted by the excellence and money-saving ability of the article. There is something radically wrong, which can undoubtedly be corrected as soon as the right man puts his finger on it. Anything *Electrical Engineering* can do to liven up the truck market will be a favor to all concerned, including the consumer."

Results of St. Louis Company's Iron Campaign.

The sale of 2403 electric irons in one day is, as a writer in the last issue of the *Union Electric Bulletin* puts it, is a good mark for any company to shoot at. This is the record now held by the commercial department of the Union Electric Light and Power Company of St. Louis as a result of an iron sale held June 9. The details of the method used to create this demand for irons in a city where irons were already in use in considerable number is of interest and is as follows: Small advertisements were used in two positions in each of six daily newspapers for three days in succession, about one week before the sale. These were followed by a large advertisement about one-sixth o fa page in size, placed in all the papers for one time on different days. On the day before the sale day (June 9), another small advertisement was used, which announced that, "Tomorrow the sale will take place."

In addition to this newspaper advertising some 30,500 return-stamped postal cards were mailed to customers, since they were the only ones permitted to take advantage of the special sale proposition, namely, to secure a $3.50 standard 6-pound household type, General Electric Iron for $2.85 and have the choice of a clothes horse or ironing board as a free gift. The printing, addressing, folding, and twice stamping of 30,500 postal cards was a considerable undertaking and required at one time 16 boys to get the cards out in two days. Besides these cards 42,000 special 9 x 9 cards were distributed throughout the residential districts of the city and hung on door knobs by an army of 53 men. These "hangers" were printed in blue on yellow and of loud design to attract the attention of the housewife. Painted calico signs were placed in the windows of the main and branch offices, and on each side of 29 commercial vehicles.

To sell 2403 irons in one day meant getting rid of 300 per hour of the ordinary working day, or 5 per minute. Customers had to be interviewed, their right to purchase investigated, orders written up and irons supplied.

From a new business point of view, these 2403 irons mean an additional connected load of 1321 kilowatts with an estimated consumption of over a quarter of a million kilowatt hours per year, and yet some companies are still wondering, "Is it worth it?"

How to Order and Maintain Electric Sign Flashers Properly.

In what follows some interesting suggestions are presented in the form of rules to use when selecting sizes of flashers for electric signs. The information is abstracted from an article by Mr. James H. Betts, appearing in a recent issue of the *Signs of the Times*:

To calculate the amperage for a flasher, multiply the number of lamps by the wattage per lamp and divide by the voltage. Thus, [No. lamps × watts each] ÷ volts =

amperes. The maximum wattage of carbon lamps should be taken as follows:

2 candle power	13 watts
4 candle power	20 watts
8 candle power	32 watts
16 candle power	60 watts

Do not figure a 2 c.p. carbon lamp at 10 watts. Very few test out that low when new, and, if they do, after a few hours' burning they will go up 11, 12 or 13 watts.

To figure the Kw.-Hr. consumption of a sign, multiply the number of lamps by the wattage per lamp and divide by 1,000. Thus, [No. lamps × watts each] ÷ 1000 = Kw. A flasher will cut down this consumption figure from 10 to 25 per cent, according to the flashing periods.

When ordering a flasher, the manufacturer should know the following details:

1. Number and candle power of lamps to be controlled by each switch.
2. Whether mazda (tungsten) or carbon lamps.
3. If mazda (tungsten) lamps, whether they are to be used on low-voltage transformer.
4. If direct or alternating current.
5. If two or three-wire system.
6. Voltage.
7. If design is complicated, give complete description of the sign, and, if possible, a sketch showing the number of lamps on each circuit and how they are to be flashed.
8. Shipment: Express or freight.

An order worded, "Ship us a fire-switch flasher," means little, and such an order cannot be filled and necessitates further correspondence and delay.

LOW VOLTAGE—HOW TO HANDLE IT.

Another important point to be remembered is the voltage: 1,100 watts at 110 volts means 10 amperes, but 1,100 watts at 11 volts means 100 amperes. Through the increased use of alternating current, brought about by the extended use of the 2½ and 5-watt low-voltage tungsten lamps in connection with a transformer, the sign and flasher manufacturer has had to make provision for handling heavy amperage. This, of course, takes more copper—such as heavier brushes, contacts and wire. Therefore, where it is possible, it is better to connect the flasher ahead (primary side) of the transformer. This is always possible on a one-switch machine, and usually so on a two, three or four-switch machine, if the load is large enough. For small loads, however, it is not advisable, as it necessitates a separate transformer for each switch.

It is inadvisable to overload a flasher, so that a liberal capacity is essential, especially where you are using low voltage tungsten lamps, as the arc is hotter than that of a carbon lamp, due to larger current used. The larger the overload on a brush the quicker it will burn out and give trouble.

INSTALLATION AND MAINTENANCE.

Install a flasher in an accessible location, preferably in a protected place, and where it can be seen and adjusted conveniently. This encourages frequent attention, for the unaccountable reason that some electricians value their life. As a vivid illustration of this, I will cite a personal (only one) experience.

About a year ago, in Birmingham, Ala., I was asked to look over a flasher operating a large roof sign. It had either been ordered wrong or the manufacturer had made an error in the construction. I was on the job and called upon for a little philanthropic advice. Positively, the only way this flasher could be reached was to climb out of a fourth-story window and go up an antiquated fire escape ladder, which hung out over the street, rounding over a projecting cornice. Before I reached the roof I had to hang by my hands and feet, with nothing between my back and the street except the smoke from the steel plant. I was as game as others who were present, but, take it from a soldier, when I reached terra firma I said to myself: "Never again for all the flashers in the United States."

Recently, in Boston, I was doubled up and hauled up two stories in a dumb waiter, although I learned afterwards that I could have reached the flasher another way (by aeroplane).

The flasher box is a simple and inexpensive thing to make, and it is preferable for the sign manufacturer to make his own, as a metal worker is better fitted for this work than a flasher manufacturer. Again, local rules vary largely in different parts of the country. A box accepted in Detroit will not pass in New York. Bearing in mind that all sides of a flasher should be accessible, an inverted galvanied iron box is preferable. Set the flasher on the cover and lift the whole box off when you wish to get at the machine.

I quote here a list of rules, many of which will apply to any machine:

Brushes—These should be kept even and should receive attention, according to the work required of them. The break should be instantaneous. The brushes should snap clear and quick, or they will carry an arc, which will cause them to heat and lose their temper and "snap." If this occurs, new brushes should be supplied immediately.

Flashers should be equipped with ball bearings, and all gears packed in graphite. If flasher is placed where it is damp, we suggest oiling the ball bearings to prevent rust. Use vaseline on the surface of contact wheels, except when used on low voltage. Never run the belts tight.

Highest Point in Florida Is 301 Feet.

Although Florida is a region of comparatively slight relief, its surface presents considerable diversity, ranging from a nearly level plain in the coastal region and the Everglades to a deeply dissected upland in the northern part of the state, where it is trenched by steep-walled valleys, and to a highland in the peninsula, where it shows many more or less rounded depressions separated by narrow divides. Altitudes within the state range from sea level to more than 200 feet above at places on the ridge that forms the center of the peninsula, and to about 300 feet above at the west end of the state, near the northern boundaries of Gadsden, Walton, Santa Rosa and Escambia Counties.

The southern part of the peninsula, comprising an area about 150 miles long and over 100 miles in average width, lies in general less than 50 feet above sea level. Narrow strips of lowland also border the Atlantic and Gulf coasts. Tallahassee, the capital of the state, stands about 205 feet above sea level, on a remnant of the upland which has been isolated by erosion. According to Water-Supply Paper No. 319, of the United States Geological Survey, based upon a list of latitudes furnished by the Seaboard Air Line Railway, Mount Pleasant is 301 feet above sea level. This is the highest accurately determined point recorded in Florida.

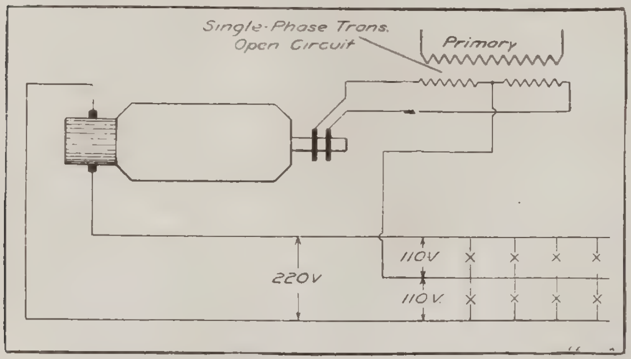
Questions and Answers from Readers

Readers are invited to make liberal use of this department for discussing questions, obtaining information, opinions or experiences from other readers. Discussions and criticisms on answers to questions are solicited. However, editors are not responsible for correctness of statements of opinion or fact in discussions. All published answers and discussions are paid for.

CONNECTIONS FOR CHANGING 2-WIRE GENERATOR TO 3-WIRE.

Editor Electrical Engineering:

(468) In further reference to question 462 in the June issue, I desire to say that I have connected the machine in question as shown in the accompanying diagram and secure successful operation. I was told by everyone consulted that my scheme would not work, yet in spite of this, the commutator is carrying several small 220 D. C. volt motors driving pumps, while the other side is carrying the 3-wire, 110 volt lighting load.



Connections Used to Get 3-Wire Operation from 2-Wire Machine.

The machine name plate shows it to be made by Commercial Electric Company of Indianapolis, Indiana, rated at 240 amperes, 220 volts D. C., at 700 r.p.m. It has six poles with the armature wound with apparently no opening and like that of a rotary converter. The connections made to slip rings as shown, span just one pole of the armature winding. The 110 volt lamps connected as shown, do not vary but slightly. Any comment on this scheme or explanation of its operation from readers will be of interest.

V. K. S.

POWER DEMAND OF ELECTRIC HOIST.

Editor Electrical Engineering:

(469) Will some reader of *Electrical Engineering* solve the following problem? I have charge of a coal hoist that is used for pulling coal cars up a 10 per cent grade, 200 feet long. The hoist is operated by a 30 horsepower, 220 volt, 3-phase, 25 cycle slip ring motor running at 690 r.p.m. at full load.

The train of gears used are as follows:

No. 1 Driving Pinion	4.5 inches, P. D.,	14 teeth
No. 2 Driving Pinion	7.5 inches, P. D.,	14 teeth
No. 3 Driving Pinion	12.0 inches, P. D.,	21 teeth
No. 1 Driven Gear Wheel ..	16.0 inches, P. D.,	47 teeth
No. 2 Driven Gear Wheel ..	43.0 inches, P. D.,	86 teeth
No. 3 Driven Gear Wheel ..	60.0 inches, P. D.,	105 teeth

The drum is 24 inches in diameter and direct connected to the 60-inch gear wheel. If the motor is taking 75 amperes what is the horsepower demand at the drum?

F. C. Deweese.

A. C. VS. D. C. EQUIPMENT FOR A SMALL FACTORY.

Editor Electrical Engineering:

(470) We are considering an addition to our plant which will call for a larger generator capacity. At present we are operating one 100 and one 50 Kw. D. C. generators engine driven, with group-drive of motors. Would like to see a discussion of the relative merits of an A. C. equipment for power and lights and as to whether or not it would be advisable to change to A. C. for an additional capacity of about 200 Kw., constant speed cotton mill load. If it is advisable, should the system be single or 3-phase? As we see it, to use our present equipment will require additional boiler capacity, considerable new piping and engine arrangements which we think may run up a cost nearly equal to a turbine installation and A. C. distribution. Any suggestions and comments will be appreciated.

W. J. R.

PROTECTION OF FEEDERS VS. GENERATORS.

Editor Electrical Engineering:

(471) The writer understands that most Westinghouse engineers advise the careful protection of feeders rather than generators. I would like to know the reasons for this and the relative cost of such protection against protection of station apparatus through the use of proper reactances. Also in case of feeder protection by use of current limiting reactances in all feeder circuits, is it to be inferred that the generators do not require additional protection?

W. C. T.

MINIMUM SIZE OF PLANT TO MAKE USE OF STOKERS AND ECONOMIZERS.

Editor Electrical Engineering:

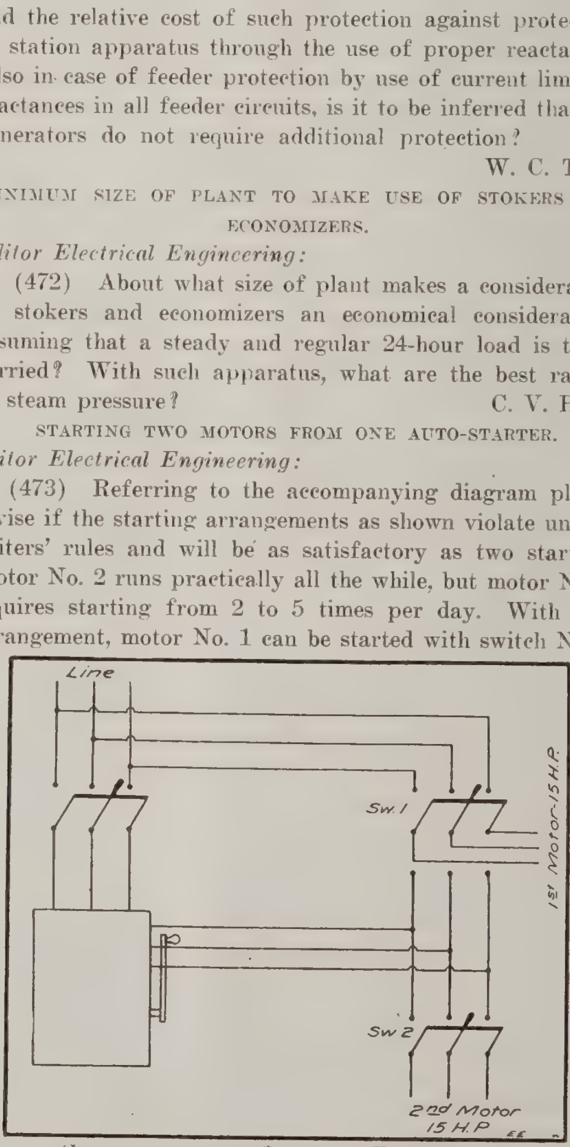
(472) About what size of plant makes a consideration of stokers and economizers an economical consideration, assuming that a steady and regular 24-hour load is to be carried? With such apparatus, what are the best ranges of steam pressure?

C. V. B.

STARTING TWO MOTORS FROM ONE AUTO-STARTER.

Editor Electrical Engineering:

(473) Referring to the accompanying diagram please advise if the starting arrangements as shown violate underwriters' rules and will be as satisfactory as two starters. Motor No. 2 runs practically all the while, but motor No. 1 requires starting from 2 to 5 times per day. With this arrangement, motor No. 1 can be started with switch No. 1



Connections for Starting Two Motors.

down and on full speed thrown up and direct on this line. This would leave the starter free to operate motor No. 2 at any time. Switch No. 2 allows the starting of motor No. 1 when motor No. 2 is stopped, or both may be started at once. If the starter is of 50 horsepower capacity will it operate satisfactorily as shown? E. P. S.

220 Volt Instruments on 110 Volt Circuits. Ans. Ques. No. 437.

Editor Electrical Engineering:

To explain the first two questions of V. K. S. in the February issue, it may be well to give a resume of the fundamental principles of ammeters and voltmeters. Except as will be noted later, ammeters are always connected directly in series with the line and voltmeters across it. Since all the current in the line passes through the ammeter, its resistance must be as low as possible, for two reasons: (1) The heating effect of the current (I^2R) would tend to burn out the instrument, and (2) this same heating effect would be a direct loss of efficiency in the circuit. Hence the coils of this type of instrument are composed of a few turns of heavy copper wire, so that the resistance is negligible.

Since a voltmeter is placed directly across the line, if its construction were like that of the ammeter, we should immediately have a short circuit, which might injure the generator and would probably burn up the instrument. Hence the resistance of a voltmeter must be so high that practically no current will flow through it. Its coils are, therefore, composed of many turns of fine wire. Outside of this difference in the coils, the two instruments are identical in principle.

Returning to the first question asked by Mr. V. K. S., there will be practically no drop in potential between the ammeter leads because of the very low resistance of the instrument, and hence the voltage of the line can have no effect on the reading. It will then read as correctly on a 110 volt line as on a 220. Similarly, since practically no current flows through the instrument, the current flowing in the line will have no effect on the voltmeter reading.

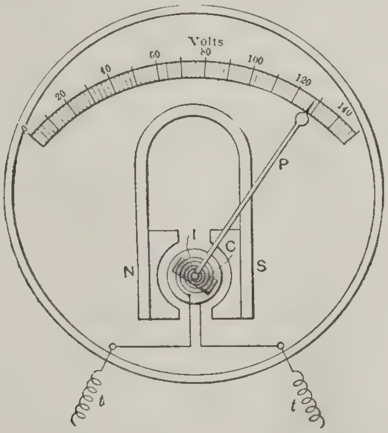


Fig. 1. Circuits of Voltmeter.

Passing now to the construction of instruments, we find the following six general types in commercial use (classification by Karapetoff): 1. Soft iron core, or electromagnetic instruments based on the attraction between a stationary coil and a pivoted piece of soft iron (used on both direct and alternating current circuit ammeters and voltmeters). 2. Moving coil instruments in which a light coil moves in the strong field of a permanent magnet (direct current only—ammeters and voltmeters). 3. Electrodynamometer type instruments, based on the attraction between a moving and stationary coil (direct or alternating current). 4. Hot wire instruments, based on the principle of expansion of a wire when current is passed through it, heating it (direct or alternating current—ammeters only). 5. Induction-type instruments, based on principle of revolving magnetic field. (Alternating current ammeters and voltmeters. These instruments are really A.C. motors in principle, but are allowed to make only a part of a revolution.) 6. Electrostatic voltmeters, based on principle of attraction of opposite charges of electricity (direct or alternating current).

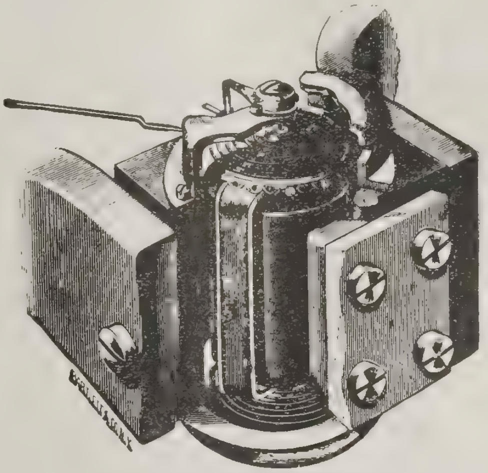


Fig. 2. Moving Coil of Meter and Pointer.

Of these instruments we will consider only Class 2, to which the Weston belongs. Referring to Figs. 1 and 2, C is a light coil of fine copper wire wound on an aluminum frame and pivoted on jeweled bearings between the poles of a strong stationary steel magnet N. S. Attached to this coil is a light pointer P. Watch springs hold the coil in place, so that the pointer rests at zero on the scale when no current is passing through the coil. A soft iron cylinder I is fixed within the coil. It offers an easier path than the air to the magnetic lines of force between the poles of the magnet, and also makes the field in the air gap uniform. Now, suppose a direct current is allowed to flow clockwise through the coil (that is, upward through the side of the coil visible in Fig. 2). The clockwise magnetic field generated by the coil will then strengthen the field of the magnet in the left side of the coil in Fig. 1 and weaken that field in the right side. Thus the coil will be rotated clockwise against the action of the watch springs to, say, the position shown in Fig. 1, the angle through which it is rotated depending on the strength of the current through the coil, and thus the strength of the magnetic field it sets up.

The instrument just described, with proper design of coils and proper calibration, could be either an ammeter or a voltmeter, but the construction of an ammeter which would carry the full line current would necessitate such heavy wire in the coil that the delicacy of the instrument would be destroyed. As commercially used, then, all instruments, both ammeters and voltmenters are, in reality, millivoltmeters. That is, a few thousandths of a volt are sufficient to cause a maximum deflection of the needle. Furthermore, the wire composing the moving coil is so fine that it can carry never more than .05 ampere, and in standard instruments is designed for about .01 ampere.

These instruments, when used as ammeters, are provided with so-called "shunts," through which the entire line circuit passes. In Fig. 3 is shown this arrangement. The shunt S is made of a low resistance alloy, having a negligible temperature coefficient, and connected in series with the main line by the terminals TT. The instrument leads are connected across the points tt, so that it becomes a very sensitive voltmeter, measuring the drop across tt in millivolts.

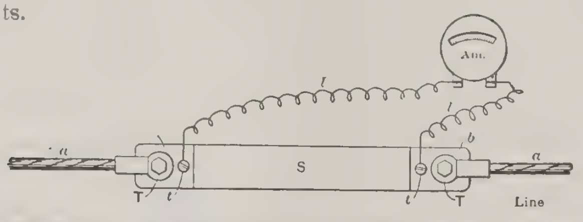


Fig. 3. Use of Shunt With Ammeter.

Switchboard instruments are identical in principle to portable instruments, but they can be made heavier and more substantial. Since large currents are likely to be encountered, an external shunt is always provided, and is placed at the back of the switchboard. Thus, as the plant grows, if currents in excess of the range of the scale are met, it would be only necessary to place a higher resistance "shunt" in the circuit and recalibrate the ammeter to it. For ranges up to 750 volts, Weston switchboard instruments have self-contained resistance (within the case), but above this voltage a separate external resistance, called a multiplier, is furnished. This is fastened to the back of the switchboard like the ammeter shunt, and is designed to obtain very high insulation.

If the correspondent wishes to pursue this subject further, the writer would refer him to text-books and articles such as "Experimental Electrical Engineering," Vol. 1, pp. 34, Karapetoff; "Elements of Electricity," Timbie, pp. 28, 387 *et seq.;* "Electrical Meters," Jansky; "Electric Journal," Vol. 8 (1911), pp. 796; "Utility of Portable Indicating Meters," Walton; catalogues of Weston Electrical Instrument Company, Newark, N. J.

V. A. Clarke (Ohio).

Cost of Steel Transmission Lines, Ans. Ques. No. 444.

Editor Electrical Engineering:

On account of the fact that the specifications for steel tower transmission lines vary through wide ranges, general data as to costs isof little value and any such information should be considered only roughly approximate except when details of installation are given. In a recent issue of *Lefax* (a monthly publication giving engineering data), the following tabulation prepared by Mr. F. G. Nagell gives a well balanced subdivision of the costs in connection with the installation of a 33,000 volt line, using No. 2 copper, 3-disc suspension insulators, 7/16 inch galvanized ground wire and 13 semi-flexible steel structures per mile.

COST OF MATERIAL AND LABOR FOR 33,000 VOLT LINE.

13 towers, 43 feet high, with cross arms, telephone clips, and pole steps complete at $53 per tower	689.00
Freight and cartage at $2.05 per tower	26.65
Digging holes at $1.50 per tower	19.50
Erecting towers at $2.00	26.00
Concrete foundations for angle towers and wet places	40.00
Guying of towers	30.00
Crushed stone for foundations	6.00
3 miles No. 2 wire at $181.20	543.60
2 miles No. 10 copper clad wire at $25	50.00
1 mile 7/16-inch S. M. steel strand wire	75.00
39 Suspension insulators, porcelain, 3 disc sets, with hooks and clamps at $3.50	136.50
26 telephone insulators and pins at 20 cents	5.20
Stringing 3 miles of No. 2 wire at $18	54.00
Stringing 2 miles No. 10 wire at $12	24.00
Stringing ground wire	20.00
Miscellaneous material	10.00
Painting towers at $1.60 each	20.80
Soldering material	5.00
Clearing and trimming trees	4.50
Damage expense to property owners	20.00
Camp expenses	16.00
Wasted materials	5.00
Contingencies and incidentals, 6 per cent	109.61
Supervision and inspection, 5 per cent	96.82
Total cost of towers and construction per mile	$2,033.18
Right of way at $15.00 per tower	195.00
Total cost including right of way	$2,228.18

In the *Engineering News* for July 20, 1911, Mr. C. D. Gray gave the following data on transmission line construction. The data refers to a 60,000 volt line, 60 cycles with No. 1 copper wire, four 10-inch suspension insulators and single ground wire. The figures do not include engineering fees nor right of way. The costs for wood poles are based on 40 foot, 8 inch top chestnut poles spaced 175 feet with a No. 8 copper clad ground wire and steel cross arms. The steel towers are spaced 500 feet apart and use No. 4 copper clad ground wire.

One single circuit wood pole line	$2,550
Two single circuit wood pole lines	5,100
One single circuit steel tower line	2,950
Two single circuit steel tower lines	5,900
One double circuit steel tower line	4,600
One double circuit with one circuit installed	3,700

In an article by Mr. J. W. Frazer taking up details of the transmission system of the Southern Power Company and appearing in the March, 1912, issue of *Electrical Engineering,* the following divisions of costs were given for a 100,000 volt line using No. 00 copper wires and with 8 suspension insulators, spacing of towers nine to the mile. Right of way is not included.

Towers	27 per cent
Insulators	8 per cent
Clamps	1 per cent
Ground wire	2 per cent
Conductor (6 No. 00 copper)	42 per cent
Labor	15 per cent
Interest during construction	3 per cent
Engineering and supervision	2 per cent

For labor costs the following items were given:

Digging holes	23 per cent
Hauling towers	9 per cent
Assembling	8 per cent
Erecting	14 per cent
Filling in holes	7 per cent
Hauling insulators	8 per cent
Hauling wire	6 per cent
Stringing 6 conductors and ground wire	25 per cent
	100 per cent

From this data it is observed that the largest part of the costs is due to conductor and towers, while insulation is a very small factor, although important. It is also to be noted and remembered that the tower cost is relatively a small part of the total cost of line and that a small additional cost due to ample design of structure is very cheap insurance as regards safety. D. H. Braymer.

Why an A. C. Wattmeter Hums. Ans. Ques. No. 451.

Editor Electrical Engineering:

The humming in an integrating watthour meter is to a large extent due to the laminations not being clamped tightly enough. The alternating flux in the iron sets these sheets in vibration, resulting in the hum. This cannot be eliminated without removing the magnet and riveting the laminations together, which would not be desirable.

Loss Due to Scott Connection of Transformers. Ans. Ques. No. 452.

In regard to the use of two transformers Scott connected for three phase load, this is not desirable if it can be avoided. If you are able to connect the 665 Kva. load to three-phase mains through the medium of three single-phase transformers, or one three-phase transformer, you will get very much more satisfactory service than if you connected to the two-phase mains through two Scott connected transformers. One reason for this is the fact that you cannot safely operate this load on two transformers each one of which is equal to one-half the rated load, or 330 Kva., because two such transformers will not safely carry this load. Where you desire to make use of this connection, it is necessary to provide 15 per cent more transformer capacity, due to the dephasing action which increases with reduced power factor. The result would be that you would probably have to install two 400 Kva. transformers to carry this load, whereas three 200 Kva. transformers would carry it safely on three-phase. The losses in three single-phase transformers would be somewhat greater than the losses for one three-phase transformer, but the combined losses would probably be at least 5 per cent less than the losses on two 400 Kva. transformers in Scott connection.

Connections to a Load Box. Ans. Ques. No. 453.

Two-phase systems are sometimes operated three-wire, in which circumstance one wire of each phase is joined to a neutral wire, thus making 110 or 220 volts from either wire to neutral, but giving 154 or 308 volts between the outer wires. In this case, if you will connect your two transformers for 110 volts and then join together one wire from each transformer for the neutral, you will have the connection desired.

Starting Large A. C. Motor by Water Rheostat. Ans. Ques. No. 455.

It is possible to use three separate water rheostats for starting a large motor. Short circuit switches should be provided, which should be closed after the rheostat is all cut out.

It is perfectly possible to operate a D. C. machine with quite a number of the coils cut out of the armature circuit. The removal of two or three coils of the generator mentioned will not impair its operation at all.

G. B. McNair (Kansas).

Connections to a Load Box. Ans. Ques. No. 453.

Editor Electrical Engineering:

My interpretation of question 453 is that there are three wires to the load box mentioned, one of which is a neutral. If so, connections would be as shown in Fig. 1.

Calculation of Secondary Current in Motor. Ans. Ques. No. 454.

There are so many variables to be taken into account that the writer would not consider it practicable to determine the current in the secondary of a slip ring motor. Besides the horsepower, current and voltage, it would depend on the slip, number of poles in primary, number of poles in secondary, on the load (which would also vary) the slip and on the frequency. Altogether, such a problem is a complicated one, which would be easier of solution by actual test than by computation, and even then would vary according as other conditions varied.

Henry A. Davis (N. Y.).

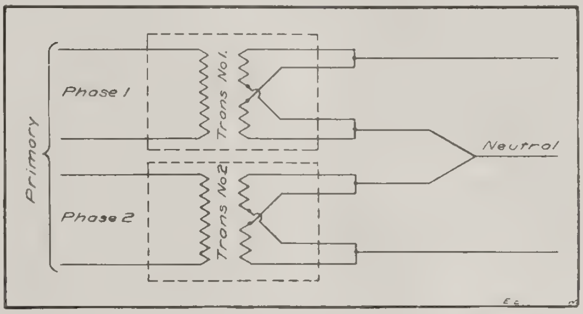


Fig. 1. Connections for Load Box.

Starting Large A. C. Motor by Water Rheostat. Ans. Ques. No. 455.

Editor Electrical Engineering:

Motors may be started by employing liquid resistances, and a very efficient and durable one is described. Fig. 1 shows the parts of a soft-pine box, shown bolted together in Fig. 2. The two important features which make this design a success is the method of cutting the middle section, M, of Fig. 1. This section is made of one piece, having the central portion cut out so as to form a box when the sides are bolted on with the arrangement of the joints, so that by turning the nuts on the bolts the joints may all be made tight by one operation. We have these rheostat boxes that are allowed to dry during the hot summer months but are ready to use by simply screwing the nuts slightly and filling with water. When the wood swells up, the joints are tight and remain so as long as in use.

The rheostat having dimensions as indicated will carry 50 amperes for several minutes without causing the liquid to boil. The current capacity may be easily doubled by using two middle sections in place of one and employing longer bolts. This would provide a box having inside dimensions of 5 inches deep, 8 inches wide, and 3½ feet long, requiring 12 inch bolts. The bolt heads and nuts are counter sunk, and provided with washers.

The electrodes E and E^1 should be nearly as wide as the width of the middle section, and may be of sheet lead or of carbon plates. The liquid used is ordinary water with the necessary amount of common salt or of sal ammoniac added to sufficiently lower the resistance.

If such a rheostat as described is used as a motor starter, it should be provided with a short circuiting switch, which should remain closed while motor is operating, but which should always be opened before attempting to start the motor. Such an arrangement has none of the desirable features of an automatic starter; or one having over-load release.

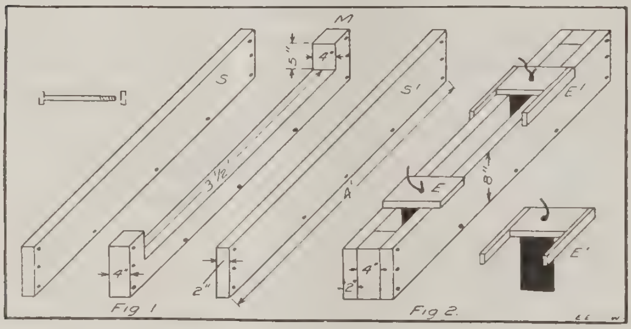


Fig. 1. Convenient Water Rheostat.

From Fig. 2 it is evident that one electrode, denoted by E^1 is movable for the purpose of varying the length of the electrolyte and hence the resistance. For a three-phase circuit one of the rheostats could be placed in each line. If desired the newly made box may be treated with linseed oil or melted paraffine to make it perfectly water tight.

Operation of Watthour Meter and Why It Hums. Ans. Ques. No. 451.

The ordinary watt-hour meter must be so constructed as to properly record the amount of work done in any interval of time. The total amount of work done in any given time is the average rate at which work is done multiplied by the time during which it is being done. An indicating watt-hour meter, must therefore perform the function of multiplying the pressure in volts by the current in amperes by the time in hours. The measurement of time is effected by causing the mechanism of the watt-hour meter to operate as a motor, whose speed depends upon the intensity of current in amperes in the circuit with which the meter is connected. The turning effort of the motor action in the meter depends upo nthe interaction of two magnetic fields; one produced by the current in the circuit; the other produced by the pressure of the circuit. One field acting alone will produce no turning effort, the two fields must act simultaneously.

When no current exists in the circuit, only one field is in action; that due to the pressure of the circuit, which is produced by a coil of very fine wire, having a high resistance, whose terminals are kept permanently connected with the terminals of the circuit. There is always a small current in the pressure coil of a meter so long as the service switch, controlling the circuit to which the meter is connected, is closed. The presence of a current in the pressure or volt-coil of an alternating-current watt-hour meter is usually indicated by the "hum" due to the alternating-field set up in the coil, which may cause loose parts of iron or steel to vibrate with the period of the field. Such vibrations or hum may be reinforced by resonance due to the covers of meters, or because meters are not firmly secured to backboards.

It is probably not possible to entirely eliminate the hum of meter. However, proper design, and care in constructing and in installing will reduce this to a minimum. One should also discriminate between a proper legitimate hum, and "grace notes." The writer was once called upon to investigate the hum of a meter, which continued when the main switch was opened. It was due to the wind blowing through a knot hole near the meter.

Prof. F. E. Austin. (N. H.)

Measuring Single-Phase Power for 3-Phase Circuit. Ans. Ques. No. 458.

Editor Electrical Engineering:

A 3-phase meter is merely an arrangement of two single-phase meters or elements, mounted on the same shaft. Each element is calibrated separately on single-phase current, and will correctly register any single-phase load within its capacity. Referring to the Fig. 1, if the load is on phase AB or BC, the element of the polyphase meter in that phase will have the regular single-phase connection, and the other element will have no current through it, so that the meter will register correctly. In the case of load on AC, both elements of the meter will register, but they will divide the load, and will register correctly.

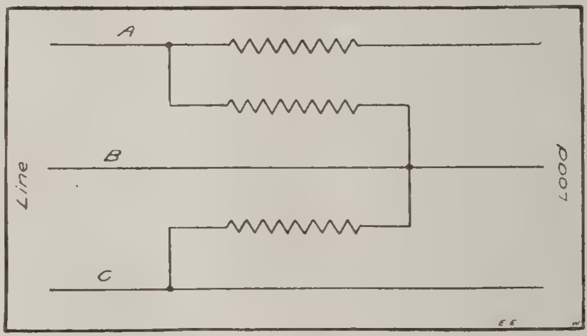


Fig. 1. Connections for Elements of Polyphase Meter.

L. M. Klinefelter. (Colo.)

Convenient Resistances. Ans. Ques. No. 456.

Editor Electrical Engineering:

Thirty-two candle power carbon filament lamps are satisfactory for making up resistances of the kind mentioned in question 456. It is an easy matter to mount them on a frame work of some kind with cleat receptacles, and they are much safer than the ordinary rheostat made up of iron wire. For ordinary purposes the resistance of these lamps may be taken at 110 ohms so that 11 lamps connected in multiple would have a resistance of 10 ohms. In the same way the resistance of any number of lamps of this size connected in multiple may be found by simply dividing the resistance of one lamp by the number of lamps. A rheostat so built up should not be used on circuits with a potential exceeding 125 volts. If the rheostat is to be used on circuits of a higher potential it should be made by connecting the lamps in series parallel. The resistance in this case will be as easy calculated as before. For example: the resistance of two lamps in series would be 220 ohms, and the total resistance of the bank could be obtained by dividing 220 by the number of series groups in parallel.

Resistance wire now on the market such as Nichrome has a much higher resistance per mil foot than iron wire and would be more satisfactory for rheostats than the telephone wire, but a rheostat made of any of the resistance materials now on the market would be more expensive than one made of lamps. The lamp bank rheostat would probably be more flexible than a home made rheostat of any other material.

Power Required by Motor Driven Pumps. Ans. Ques. No. 457.

The curves given below are based on a pump efficiency of 50 per cent and sufficiently close for practical purposes. The centrifugal pump is a very inefficient piece of machinery. While as high efficiencies as 65 or even 70 per cent are at times obtained on these pumps it should be borne in mind that operating conditions are never ideal. The efficiency of the centrifugal pump reaches a maximum when it is driven at the speed and operating under the head for which it is designed. Any slight change in these conditions always decreases the efficiency. The writer is familiar with several installations in the West that were made on the basis of a pump efficiency of 65 per cent. These installations have nearly all given trouble and actual tests have shown that in nearly every case the motor was over-loaded.

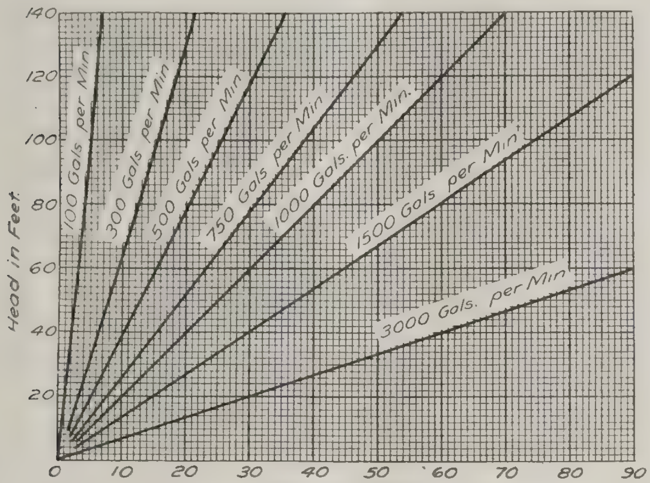


Fig. 1. Diagram Showing Power Required for Pumping.

A splendid bulletin on tests of centrifugal pumps was issued by the experiment station of the New Mexcio College of Agriculture and Mechanic Arts, in 1911. It shows the performance of several different makes of centrifugal pumps under different conditions of speed, head, etc., and is a splendid reference on the subject. It can be obtained for the asking if it is still in print.

Changes Necessary in 2-Wire Generator for 3-Wire Service. Ans. Ques. No. 462.

In answer to problem 462, I would say that a 220 volt, 2-wire D. C. generator cannot be used to supply a 3-wire, 110-220 volt lighting circuit even if lamps of the same size are used. It would be possible to use this machine with 110 volt lamps provided your lamps are wired two in series, but this would necessitate changing the wiring in most cases. Care must also be taken that the two lights of a series group have the same voltage rating, and that they are of the same wattage.

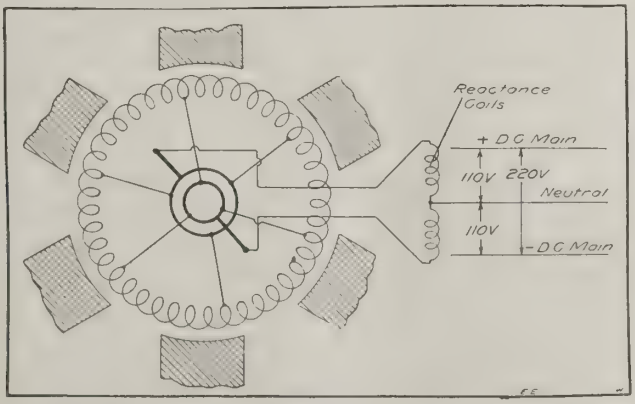


Fig. 2. Diagram of Changes Necessary in 2-Wire Machine for 3-Wire Service.

The accompanying diagram shows how the machine in question may be changed to a 3-wire generator by the addition of two slip rings and six taps to the armature winding. The leads from these two slip rings must be connected together through two similar reactance coils connected in series. The writer has frequently made use of old transformers for this purpose, cutting out the primary and connecting the two secondary coils in series across the leads from the A. C. brushes. What is usually the neutral of the transformer when in use on A. C. circuits becomes the neutral of the 3-wire system when connected as above. A 5 Kva transformer with two 110 volt coils would be entirely satisfactory for the machine under consideration. Such an arrangement would not change the capacity of the D. C. generator provided the load is reasonably well balanced.

It is usually quite expensive to change a machine over in this way and it is likely that a standard 3-wire balancer set could be bought and installed for the cost of doing the work outlined above. F. J. Rankin. (Colo.)

Arrangement of Lamps for Special Display. Ans. Ques. No. 461.

Editor Electrical Engineering:

To connect 53, 5 watt, 13 volt lamps to a 110 volt supply in 5 banks of 10 lamps in multiple, and one of three in parallel as stated in the question, the following resistances will be required: A resistance of 4.82 ohms, capable of carrying 2.7 amperes, should be placed in parallel with the three lamp bank, and a resistance of 8.42 ohms, capable of carrying 3.84 amperes, in series with the six banks. The loss will be about 160 watts in the two resistances.

If the lamps can stand a small variation in voltage from normal, they might be connected in 5 banks of 9 lamps in series, and one bank of 8 lamps in series, across the line. The sets of 9 lamps would be operating at about 12.25 volts per lamp, and the sets of 8 lamps at about 13.75 volts.

L. M. Klinefelter. (Colo.)

Horsepower of Motor to Operate Pumps Under Various Heads. Ans. Ques. No. 457.

Editor Electrical Engineering:

The make of pump is not specified in question 457, therefore no exact efficiency values can be used in the following formula. However, it has been found that 63 per cent is a very good average value for the efficiency of single stage, single suction centrifugal pumps of varying sizes. Using 63 per cent for the pump efficiency and remembering that one gallon of water weighs 8.31 pounds, also that one horsepower equals 33,000 ft. lbs. per minute; we have,

H. P. = [8.34 × gallons per minute (G) × Head in feet (H)] ÷ 33,000 × .63 = .0004 × G × H.

The above formula does not take into account the friction head which varies with size of pipe, number of bends, etc. This formula is the one in general use, however, and is accurate enough for practical use. For sea water the result should be increased by 1.026. Curves showing horsepower vs. head in feet, and plotted with each constant and the other varying, are given for different values of gallons per minute, in the "Standard Handbook for Electrical Engineers," third edition, page 1276.

Either D. C. or A. C. motors are satisfactory for operating centrifugal pumps. For most cases shunt wound D. C., and squirrel-cage A. C. motors are suitable; but when starting conditions are severe, as when starting pump against a full discharge head, the compound wound D. C. and phase wound A. C. motors should be used. A pump which is used to deliver water at various rates is quite liable to overload the motor. It is also extremely important that a pump be worked as near as possible to the flow for which it was designed; the efficiency is much higher and the pump will give much greater satisfaction.

Kent's Mechanical Engineers' Handbook, 8th edition, pages 764-770, contains much valuable data on centrifugal pumps. Howard R. Smith. (N. J.)

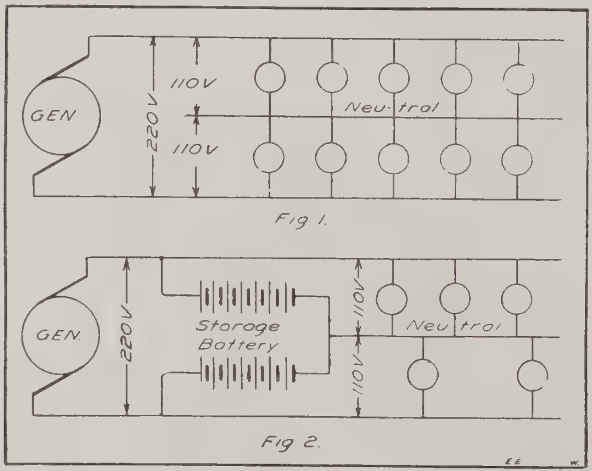
Changes for Connecting 2-Wire D. C. Machine to 3-Wire System. Ans. Ques. No. 462.

Editor Electrical Engineering:

In answer to V. K. S.'s question, No. 462, in the June issue of *Electrical Engineering*, the writer will say that a 220 volt, 2-wire D. C. generator can be successfully used to supply a 3-wire 110-220 volt circuit, in several different ways, as follows:

(1st) If the system is perfectly balanced, that is if both sides have the same number of lamps of the same size connected between the neutral and the outside wires, then all that is necessary is to connect the outside wires to the generator as shown in Fig. 1. This system is unsatisfactory, because in the first place it is necessary to switch on the same number of lamps on both sides at the same time, and secondly, should several lamps burn out on one side, it would throw the system out of balance, causing the fewer lamps to burn brighter than those on the other side.

(2nd) The neutral wire may be connected to the middle point of a storage battery, the voltage of which is equal to the voltage of the generator, in order that each half may maintain the voltage desired for the lamps. Fig. 2 shows the connections. Each half of the battery will discharge when the number of lamps burning on its side greatly exceeds that on the other, and the other side will be charged. When the system is balanced, no current flows through the battery. The cells must be occasionally inspected to ascertain an even discharge.



FIGS. 1 AND 2. CONNECTIONS FOR 3-WIRE SYSTEM.

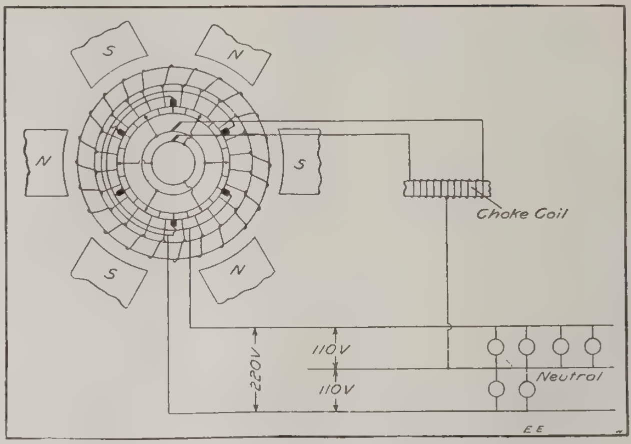


FIG. 3. CONNECTIONS FOR 3-WIRE GENERATOR.

(3rd) This method also answers the second part of the question. In this method two slip rings are placed on the shaft and each ring is connected to equipotential points (two for each pair of poles) on the commutator, or armature winding. A choke coil is connected across the two slip rings and the neutral wire of the three-wire system is connected to the middle of the choke coil. The E. M. F. between the neutral and the outside wires will be practically the same. On account the self induction of the choke coil, very little A. C. current will pass between the two rings, but the D. C. current will readily pass to or from the neutral wire. Fig. 3 shows the connections for a 6 pole, 2-wire generator. The capacity of the generator is in no way affected. A. J. Kalinowski. (Colo.)

Measuring Single-Phase Power From a 3-Phase Circuit. Ans. Ques. No 458.

Editor Electrical Engineering:

Since any three-phase meter is two-single phase meters in one case, it is evident that any load, inductive or otherwise, taken from phases AB or AC will be recorded correctly. Since the angle of displacement between each potential element of the meter and any non-inductive load on phase BC is 60 degrees, which gives a power factor of ½, each element will measure ½ the current times potential. With any inductive load on BC the power-factor will fall below ½, one element of the meter will record in a forward direction and the other will tend to record backwards, thus the reading will be correct. The latter is a case where if one of the potential coils should open, the meter would record faster than it should. J. G. Longfellow. (Va.)

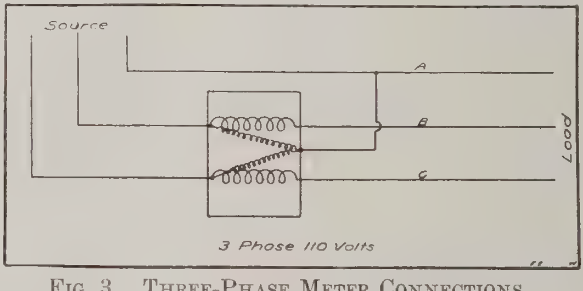


FIG. 3. THREE-PHASE METER CONNECTIONS.

Power Taken By Pump Motors.

Editor Electrical Engineering:

The writer is employed by a power company that supplies power for pumping purposes, and uses 2200 volt, 3-

phase A. C. motors. All motors have individual meters and as I have frequently been asked how much load such and such a motor is pulling, I have computed a chart which is herewith shown, for direct reading of the kilowatt input, timed by the revolution of the meter disk. I find this very handy as it saves time and is as nearly correct as can be estimated on a rough test for one minute, using a dollar watch for timing.

The table is based upon the following data:

Speed of (5. Amp.) meter × 0.8 = K.W. or × 1.07 = H. P.
Speed of (10. Amp.) meter × 1.6 = K.W. or × 2.14 = H. P.
Speed of (15. Amp.) meter × 2.4 = K.W. or × 3.21 = H. P.
Speed of (20. Amp.) meter × 3.2 = K.W. or ×4.28 = H. P.
Speed of (25. Amp.) meter × 4.0 = K.W. or × 5.36 = H. P.
Speed of (30. Amp.) meter × 4.8 = K.W. or × 6.43 = H. P.

Example: For a 20 amp. meter, 15 r. p. m. of the disk = 15 × 3.2 = 48.0 K.W. per hour, or 15 × 4.28 = 64.4 H. P.

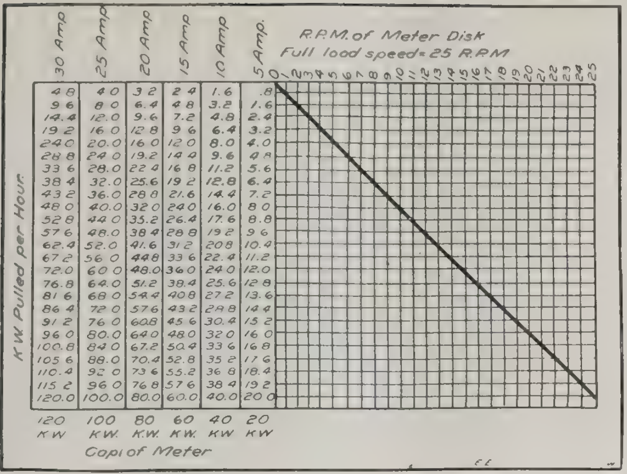


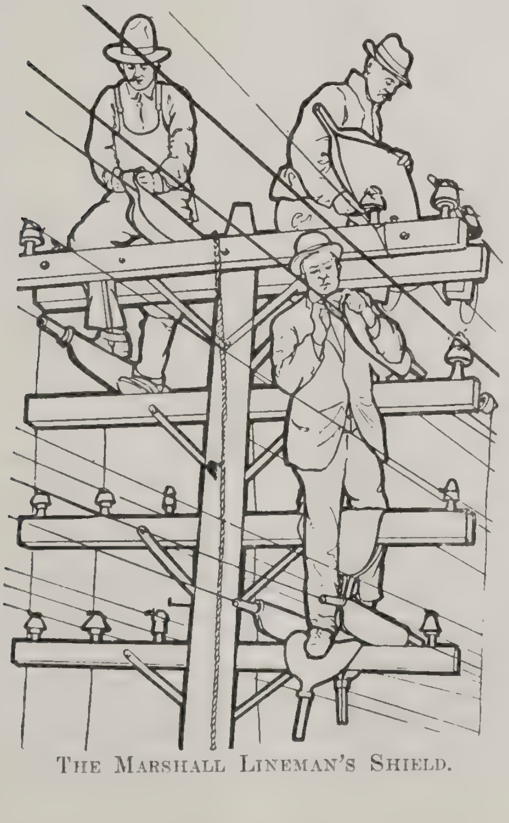
Fig. 1. Approximate K. W. and H. P. for 2200 Volt Westinghouse Power Meter With Current and Potential Transformers to correspond With the Meter.

New Apparatus and Appliances

A Lineman's Protective Device.

A device for the protection of linemen when working on high tension circuits has been devised and is being successfully sold by the Linemen Protector Company of Detroit, Mich. This device has been approved by the Fidelity and Casualty Company of New York, by the N. E. L. A. committee on accident prevention in its report at the recent Philadelphia convention and being used in large numbers by about 550 central stations throughout the country. The Public Service Electric Company of New Jersey uses 262, the Philadelphia Electric Company 138, the New York Edison Company 158, and the Edison Illuminating Company of Detroit, 118.

The nature of the device as shown in the accompanying illustration is simply an extra insulation in the form of a rubber trough called by the manufacturers a shield and made for easy application. It covers not only "live" wires, but "tie" wires and taps if there be any. Rubber handles are provided for applying the shield, arranged in such a way that it is always between the hands of the wireman and the wires. When in place, a split, hard rubber ring clamps the shield firmly to the wire.



The Marshall Lineman's Shield.

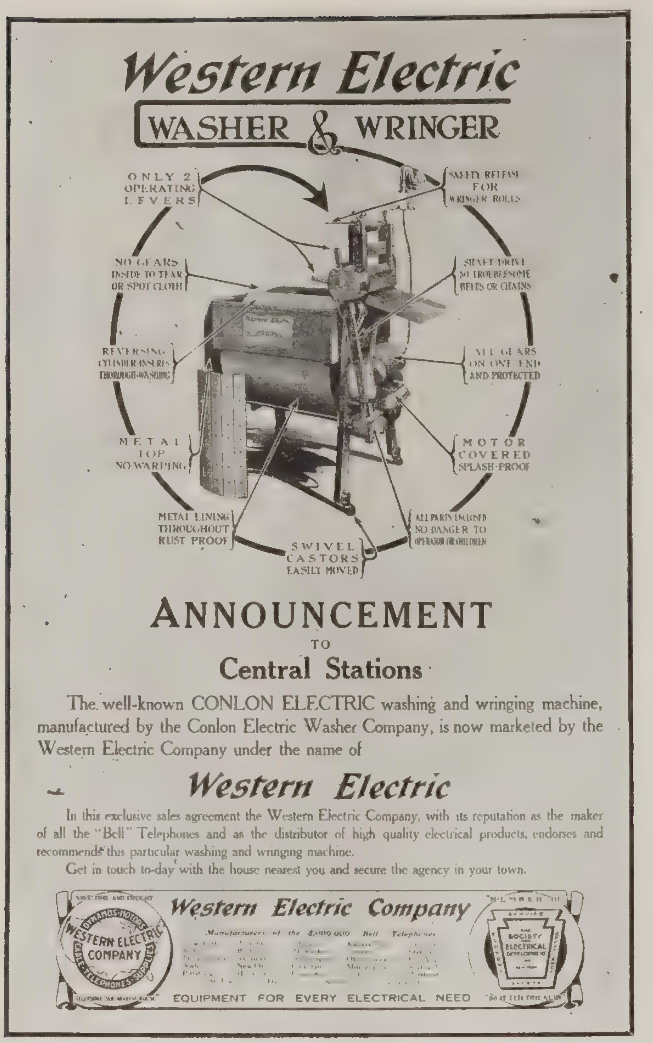
This device is recommended by the manufatcurers for use on all "live" circuits not exceeding 10,000 volts. It is in use, however, on circuits carrying as high as 12,500 volts.

One company which has used these shields for the past six years reports finding them a time saver as well as a great protection to the men. In April of 1908 one of their foremen stated that they worked on 4,600 volt 3 phase circuits under all weather conditions, and had not found it nesessary to cut out any circuits in order to make taps, or do repairs to them, or shut down to move any transformers, during the eighteen months which the shields had been in use. Prior to their use two men were killed within a year through short circuits while working on the high tension wires. Since adopting them they have not had an accident or a man burned while using them.

The manufacturers recommend 4 or 6 shields per wagon for use on single phase circuits up to 2,000 volts and eight per wagon on all other circuits. It is a good idea to carry them in a box in the wagon when not in use, so as to afford protection from wet, grease, or mechanical injury as far as possible. The shields are made of live rubber, no reclaimed rubber being used and cost $35 apiece. On this basis they are not only an economical protection but a thoroughly good investment on which a return will be made in loyalty by employes in times of emergency or other trouble.

Western Electric Company Starts Electric Washer Campaign.

As announced in the June issue of *Electrical Engineering* the Western Electric Company has secured the exclusive sales right for the Colon electric washing machine. The


Western Electric
WASHER & WRINGER
ONLY 2 OPERATING LEVERS
SAFETY RELEASE FOR WRINGER ROLLS
NO GEARS INSIDE TO TEAR OR SPOT CLOTH
SHAFT DRIVE NO TROUBLESOME BELTS OR CHAINS
REVERSING CYLINDER INSURES THOROUGH WASHING
ALL GEARS ON ONE END AND PROTECTED
METAL TOP NO WARPING
MOTOR COVERED SPLASH-PROOF
METAL LINING THROUGHOUT RUST PROOF
ALL PARTS ENCLOSED NO DANGER TO OPERATOR OR CHILDREN
SWIVEL CASTORS EASILY MOVED
Western Electric Company
Manufacturers of the 8,000,000 Bell Telephones
EQUIPMENT FOR EVERY ELECTRICAL NEED

ANNOUNCEMENT
TO
Central Stations

The well-known CONLON ELECTRIC washing and wringing machine, manufactured by the Conlon Electric Washer Company, is now marketed by the Western Electric Company under the name of

Western Electric

In this exclusive sales agreement the Western Electric Company, with its reputation as the maker of all the "Bell" Telephones and as the distributor of high quality electrical products, endorses and recommends this particular washing and wringing machine.

Get in touch to-day with the house nearest you and secure the agency in your town.

The Western Electric Company's Washer Announcement.

accompanying illustration is made from the first page of a six-page folder explaining the washing machine proposition and the sales help that the company is prepared to give those who can handle the retail sales. This service includes the furnishing of advertising plans, electros for newspaper advertisements, lantern slides, window displays and street car cards, together with a full line of attractive literature. This literature includes a number of booklets and folders envelope size and bearing the imprint of the company to whom they are furnished.

The campaign is one in which central stations should be interested, as the washer is well designed, substantial and moderate priced.

Ostrander Pull Sockets.

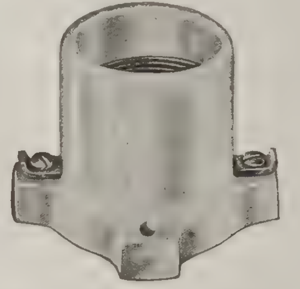
The accompanying illustration shows a new type of pull socket manufactured by W. R. Ostrander and Co., 22 Dey Street, New York City. The socket mechanism is a double make and double break of liberal design with a chain insulated from the mechanism by a spindle passing through the porcelain and preventing its carrying any current.

The Ostrander Pull Socket.

The cap is provided with three tongues, each engaging a pocket or loop in the shell and when once locked stays. In this position the socket will carry the heaviest shade made without danger of the shell becoming loose.

A New Receptacle for High Candlepower Lamps.

The present tendency of the illuminating engineer is to replace clusters of small candlepower incandescents, and other lighting units with a single large base lamp of high candlepower. To meet these particular conditions the Bryant Electric Company of Bridgeport, Conn., has designed a new porcelain receptacle which is suitable for the highest candlepower lamps which have yet been developed. This receptacle is approved by the Underwriters Laboratories at a rating of 1,500 watts, 250 volts, and provides for the Mogul base lamp a receptacle of the same type and design that experience has proven to be extremely useful for medium base lamps.



A New Porcelain Receptacle.

It may be used with many types of indirect and semi-indirect fixtures, as well as for exposed wiring. All live parts on the back of the receptacle are sealed in with a permanently hard compound which will not be affected by any heat to which it can be subjected in service.

New General Electric Single Phase Watthour Meter.

A single-phase watthour meter, which is said to represent a distinct advancement in the design of meters operating on the induction principle, has recently been placed on the market by the General Electric Company. The features embodied are high initial and maintained accuracy, micrometer adjustments, solid structure, assuring permanent alignment of working parts, very legible register, easy access for inspection and repairs, simple construction, compact design and neat appearance. The meters are offered self-contained in capacities of 5 to 300 amperes, 110 or 220 volts, 2-wire, and 5 to 150 amperes, 220 volts, 3-wire, 25 to 133 cycles.

The mechanical design of the meter is a marked departure from that heretofore used. The base, or central iron casting, supports the complete motor element on the inside, and the damping magnets, bearings and registering mechanism on the outer or front side. An extension at the bottom forms the terminal box. The fact that all working parts are rigidly attached to this single integral casting assures accurate alignment during operation, while being transported, or if necessary, to take apart and reassemble.

The rotating element consists of an aluminum disk mounted on a vertical shaft with a worm cut in the upper end, which transmits motion to the worm wheel at the back of the register. The magnetic circuit is in two sections

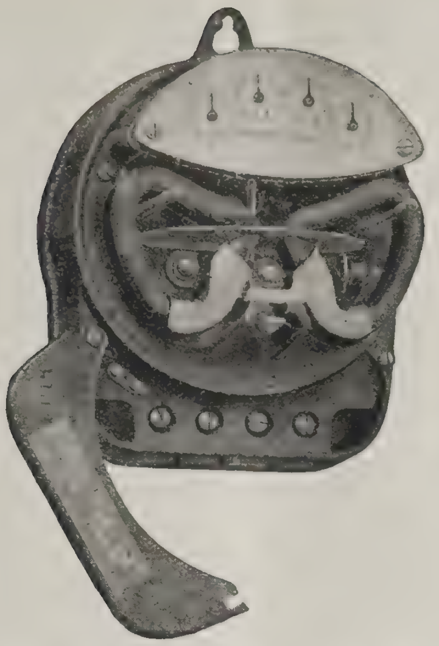


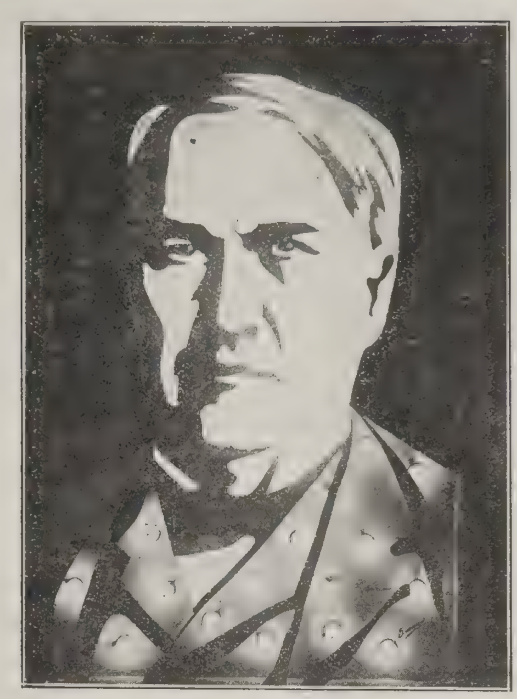
Fig. 1. New General Electric Meter With Cover Removed and Terminal Cover Open.

rigidly fastened together by two punched iron reinforcing plates. There are two current poles and one potential pole. Three screws hold the entire element in position inside the base. The permanent magnet, by means of which the speed of the disk is regulated, has two individual magnets astatically arranged and mounted in a brass shoe. It is supported by a shelf on the main casting and provided with micrometer adjustment. Turning the screw clockwise draws the magnet out, decreasing the speed of the disk, and vice versa. A slotted and knurled thumscrew gives micrometer adjustment for light load by moving a metal punching laterally under the potential pole in the path of the potential flux. Two brass studs project from the moulded compound in the terminal box, joined by a small brass connection strap, by means of which the potential circuit may be opened and any number of meters tested in series.

Two holes punched diametrically opposite in the disk prevent creeping or turning on potential alone. The meters are practically unaffected by variations in voltage 10 per cent above or below standard ratings. Ordinary variations in temperature, small changes in frequency met with in lighting circuits or variations of wave form of generators for such service also do not affect their accuracy appreciably. A lagging device, consisting of a rectangular copper punching in the form of a short-circuited loop and attached to the light load plate, compensates the meter for inductive loads. It is tested and adjusted at 0.5 power factor. The iron case surrounding the electrical element protects it from the effects of ordinary external stray fields.

Thomas A. Edison By an Electric Portrait.

One of the electrical decorative features at the recent convention of the National Electric Light Association in Philadelphia, was an electrical portrait of Mr. Thomas A. Edison, made from his recent photograph. This portrait brought out Mr. Edison's face in a most realistic way, the various colors being faithfully portrayed, such as flesh color, hair, collar and tie, and coat. The whole had an appearance of being a well illuminated oil painting, although carried out in somewhat of a poster effect.

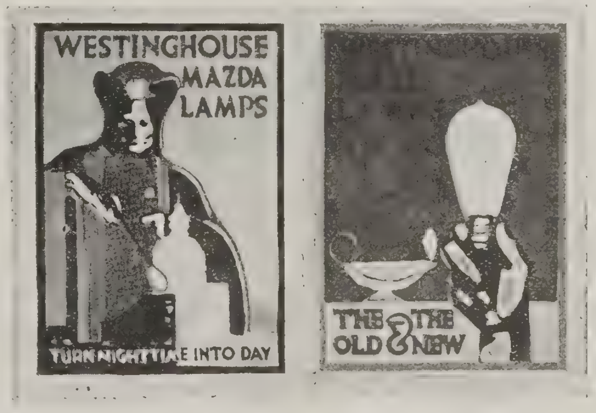


Electrical Portrait of Mr. Edison.

At the close of the convention Mr. T. C. Martin presented the portrait to Mr. Edison with the compliments of the electrical men of the country. The picture was made by the Greenwood Advertising Co., under the Tucker-Leach patents pending, and is an ingenious piece of work, the high lights and shadows being reproduced by reflections and re-reflections. The entire display is made of metal, and surrounded with a frame.

Advertising Stamps Used by Westinghouse Lamp Company.

The Westinghouse Lamp Company is making use of a unique advertising novelty in the shape of stamps that call attention to the use of mazda lamps. These stamps are one and one-half by two inches, printed in colors and will be used on backs of envelopes, packages, etc. While various advertisers have used the scheme in one form or another, the Westinghouse Company is the first electrical firm to adopt it.



Advertising Stamps Used by Westinghouse Lamp Company.

Electrical Construction News

This department is maintained for the contractor, dealer, manufacturer and consulting engineer.

ALABAMA.

BIRMINGHAM. Additions to several plants of the Tennessee Coal, Iron & Railway Co., are to be made at a cost of approximately $85.000.

DATEVILLE. The Alabama Power Co. is planning to erect a hydro-electric development at Cheroflee Bluff on the Tallapoosa River. This company also plans to extend its transmission line from Gadsden to Huntsville and other towns in the northern part of the tsate.

GURLEY. The Gurley Light & Power Co. is to rebuild its plant recently destroyed by fire. A 40-H. P. engine and 60 K. W. generator with boilers and auxiliary apparatus will be used.

HUNTSVILLE. E. C. Dillon and others have applied for a franchise to furnish electricity and natural manufactured gas in Huntsville. Energy will be purchased from the Chattanooga River Power Co., at the Hales Bar development.

FLORIDA.

TAMPA. The Stone & Webster Company is to make additions to its boiler plant, constructing a new boiler house and smokestack.

GEORGIA.

ATLANTA. It is understood that the Georgia School of Technology is to install a power plant for supplying light and power to the buildings and for laboratory use.

CONYERS. The Panola Light & Power Co. is to install a 500 H. P. unit in its hydro-electric plant. The energy will be transmitted to Conyers and Lithonia, Ga.

FITZGERALD. It is understood that the Fitzgerald Water, Light & Bond Commission is to install a 500 H. P. engine and 375 K. W. generator in the early future. W. A. Green is superintendent.

MILLEDGEVILLE. The Oconee River Mills Co. is to install water wheels and electrical equipment in a new power house. Hall Bros., Peters Bldg., Atlanta, Ga., and J. N. Eley, of Atlanta, are engineers.

VALDOSTA. The city is to install a 75 K. W. direct connected unit and make improvements to their distribution system, constructing new lines and installing about 500 incandescent and 100 arc lamps. C. S. Quarterman is superintendent.

KENTUCKY.

OLIVE HILL. The Tygart Electric Co. has been incorporated with a capital stock of 08,000 to construct an electric light and ice plant. J. A. Maddox and others are interested.

SHEPPARDSVILLE. The Sheppardsville Electric Light, Ice & Water Co. has been organized with a capital stock of $10,000, by S. W. Bates, W. E. Ashby and W. P. Lee and others.

MISSISSIPPI.

MERIDIAN. The Meridian Light & Railway Co. will erect a fireproof engine and boiler room, and install a 500 H. P. boiler. A recent explosion destroyed a part of this plant some time ago. W. G. Shurgar is architec, of Meridian.

SOUTH CAROLINA.

CHARLESTON. The Santee Cooper Development Co. has been recently organized to construct a navigable canal between the Santee and Cooper Rivers, and the building of a hydro-electric plant at the intersection of the proposed water way.

WALHALLA. The city has voted $6,000 in bonds to construct an electric light plant.

Personals.

H. A. STRAUSS, consulting engineer of Chicago, has been retained by the bondholders' committee of the Alton, Jacksonville & Peoria Railway Company to prepare a complete valuation of the company's property.

This valuation report is to be submitted to the Illinois State Public Utilities Commission in connection with the application for authorization of re-organization of this company and the issuance of stocks and bonds thereunder.

This will be the first extensive valuation on an interurban railway submitted to this commission.

MR. L. S. MONTGOMERY, formerly district manager of the Atlanta office of the National Metal Molding Company of Pittsburgh, Pa., and later in charge of the Pittsburgh district, has recently been appointed Canadian representative of the company, with headquarters at Buffalo, N. Y. He is now making a trip through the province of Quebec, making Halifax, Nova Scotia, and St. Johns, Newfoundland. Mr. Montgomery has many warm friends throughout the South whom we are sure wish him every success in his new field.

Elbert Hubbard Makes a Little Journey to Knoxville!

The Sage of East Aurora recently spent a day in Knoxville. He went through our plant and saw how we make Individuality Signs. In the June issue of The Fra, he wrote:

"In Knoxville they will tell you that the mention of the State on the envelope is a superfluity, just as no well-bred person today speaks of 'Chicago, Illinois.'

"If you want to see the 'New South' at its best, go to Knoxville. Here is a city of a hundred thousand people where the noble discontent prevails. Nothing in Knoxville is quite good enough—it must be made better.

"Knoxville is the home of the electric sign. Here the Greenwood Company employs a goodlie companie of artists who get up original designs from which permanent signs are made. The signs are made of metal, are fool-proof, and can be operated anywhere there is a central station. Just to give me a little thrill these sign boys made a portrait of me with the help of the electric bulbs. There it was—a superb likeness—hanging from an arch across the middle of the street. It sort of gave me the creeps. Think of the possibilities of such a thing a few hundred years ago as a scheme for collecting revenues and enforcing obedience.

"To make a portrait with the help of electric lights is a thing never before accomplished. Let the credit go to Knoxville, the home of Individuality."

GREENWOOD ADV. CO.

KNOXVILLE, - - - - - - TENNESSEE

Western Factory at Los Angeles.

W. A. ZIMMERMAN, formerly secretary and general manager of The Mercury Mfg. Co., has been made director of sales and publicity for the Buffalo Vehicle Co.

F. C. BROWN, formerly district manager for The Chase Motor Truck Co., has been made sales manager of the truck department of the Buffalo Electric Vehicle Co.

MR. GEORGE C. ISBESTER, who for the past three years has been associated with the New York office of The Rail Joint Company, has been given charge of the Chicago Office, No. 215 Railway Exchange.

THE DETROIT INSULATED WIRE COMPANY, of Detroit, Michigan, announces the following re-organization: Mr. Joseph H. Hunter, president; T. G. Splane, vice-president; James Inglis, chairman board of directors; and C. C. Gray, secretary and treasurer.

Mr. Joseph H. Hunter, president of the Company was one of its original incorporators, having served as vice president and general manager and succeeded to the presidency on February 20th, 1914, the present prominence of the company in the wire field being due to his efforts. Mr. Hunter was formerly vice president and general manager of the National Cable & Wire Co., and has been identified with electrical matters and manufacturing for many years.

Mr. J. G. Splane, the new vice president, is a Pittsburgher by birth, in which city he received his education, being a graduate of the University of Pittsburgh. He held a responsible position with the Standard Oil interests from 1887 to 1903, and on May 18th of that year was elected president of the Pittsburgh & Allegheny Telephone Company. As a protectory measure on the part of the minority stockholders, Mr. Splane and the Hon. William Flinn were appointed reivers for the company on January 10th, 1911, and on June 1st, 1914, the property was re-transferred to its stockholders and the receivership terminated, Mr. Splane at that time being named Managing Director of the company. By reason of his connection as director with several manufacturing enterprises, his diversified business experience and his acquaintance in the telephone field, Mr. Splane's association with the Detroit Insulated Wire Company should be of great benefit to that company, and such a result is confidently anticipated.

Mr. James Inglis, who becomes chairman of the board of directors, has been connected with the company as a stockholder since its inception. Mr. Inglis' business career practically originated with the American Blower Company, he being identified with that company since early manhood and as its president for the major portion of the time, and under his management it emerged from comparative insignificance to its present pre-eminent position. He is also a director of the National Bank of Commerce and the Michigan Savings Bank, was one of the originators of the Detroit Board of Commerce and its President from April 1st, 1906, to April 1st, 1907, and is also financially interested in and officially connected with a number of other going concerns. Mr. Inglis lends to the Detroit Insulated Wire Company his broad and well-balanced business experience, and while his official connection with the Company is largely in ad advisory capacity (his energies continuing to be devoted to the American Blower Co.), it is felt the moral effect of his official association with the Detroit Insulated Wire Company will make for added strength and influence.

Mr. C. C. Gray, the secretary and treasurer, has had charge of its selling activities since September, 1912, and formerly held a similar position with the National Cable & Wire Co. Mr. W. G. Dalgleish is assistant secretary and treasurer.

MR. J. G. ROHRMAN has been appointed district sales agent of the Western Conduit Company of Youngstown, Ohio, with offices at 1513-14 Healey Bldg., Atlanta, Ga. Mr. Rohrman will also act as sales agent of the Youngstown Sheet and Tube Company of which the Western Conduit Company is a subsidiary. The latter company is well known as miners of ore and coal and manufacturers of pig iron, open hearth and Bessemer steel with extensive works at Youngstown, Ohio. All the products of both companies will be handled through the Atlanta office, and include full weight wrought steel pipe in sizes of ⅛ inch to 20 inches and genuine wrought iron pipe in sizes of from ⅜ to 12½ inches. The latter is known as the "Star" brand in both black and galvanized grades. New process galvanized roofing sheets, painted and galvanized, and black and galvanized flat sheets in both steel and genuine old fashioned puddled iron are handled. This company also produces a complete line of wire products, such as standard wire nails and staples, galvanized and painted barbed wire, "Buckeye" woven wire fencing and kindred lines. The conduit line consists of electro-galvanized and black enameled known under the trade name of "Buckeye," supplemented by a line of armored conductor known as "Realflex," a new cable possessing features of flexibility, durability and ease of installation for interior work.

The southern territory covered through the Atlanta office will include Georgia, Alabama, Florida, North and South Carolina and Eastern Tennessee. Mr. Rohrman comes to the south with an intimate knowledge of the iron and steel business, having spent his entire career in this line of work and having been connected with LaBelle Iron Works and Carnegie Steel Company before joining the organization of the Youngstown Sheet and Tube Company. All products of both companies he represents will be handled through jobbers and through the regular channels of the trade.

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ELECTRICAL ENGINEERING

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Europe's War and American Business.

Just as the business interests of this country have reached a point where they begin to see the light through a long period of cloudy legislation, along comes an international disturbance in the shape of war involving practically all Europe and foreign trade. This war is now regarded as an awful tragedy, which, if prolonged, will probably change the map of Europe, waste billions of dollars and cost millions of lives. Some of the bad effects following the declaration of war among countries commercially close together are beginning to be felt in this country and the final results of the trouble are variously viewed, depending upon the state of mind and interests of the prophet. As far as the electrical industry goes, one authority who is associated in an executive capacity with one of our largest manufacturing companies, sees in the war a chance for American manufacturers to overtake the Germans and to profit largely by the orders which will necessarily be diverted to this country on account of the war. This opinion is being confirmed by the orders that are said to be already coming in. This same authority further predicts that in case the war lasts two years, German electrical manufacturers will drop out of competition with American firms for at least ten years.

With a confidence in American business that it justly deserves, a relief from further tinkering with the basis on which our main lines of commercial activity can be promoted, we can see no reason why, with good crops and increased facilities for handling and working the money of this country, that all lines of business, including new electrical construction and extensions to present operating systems in this country should not go on in at least as satisfactory a manner as in the past year or so—an activity which as far as the South goes, we enter no complaint against.

Present Day Lighting.

When we look back over 35 years of lighting progress, since the invention of the incandescent lamp and view the development as a whole, a series of accomplishments are surveyed and their benefit to humanity is realized. Yet when we become analytical and examine the steps of this development, a marked period of results appears as one great hump on the upward curve of achievements followed by a series, the one towering above the other and all credited to the past six or seven years or that time since the discovery that the art of illumination obeys definite scientific laws. In the formulating and applying of these laws, so as to secure results economically, light sources have undergone a decided evolution until they are now a fairly definite quantity. While it has taken years to learn that the carbon filament lamp could never be made sufficiently efficient for extensive use, many things have been learned during this development. Foremost among these things are ways and means to secure and use light from the other more efficient types of light sources taking the place of the carbon lamp, so as to successfully meet the increasing demand for light on a cost basis that is fair to the current producer and the current user.

The great army of users of electric light at the present time demands high quality at low cost, yet few indeed even know the details of the evolution making such possible—how the light producing filament was conceived, developed and placed within their easy reach. Such names as Sir Humphrey Davy, Foucault, Wright, Maxwell, Brush, Thomson and Houston mean nothing at all. Not until the name of Thomas A. Edison is mentioned does any real appreciation become evident, for to him has been generally given the credit for producing the first commercially practical incandescent lamp, a condition that has been largely brought about through Edison's far-sightedness and appreciation of the field for incandescent lighting and his work in making possible machines and distribution systems for the operation of such lamps.

Today the problems of power generation and distribution and consequently one of the difficulties in application of lighting units, are well in hand. This situation has been brought about not by any single individual, but groups of individuals, men who have risked millions of dollars and stood back of manufacturing organizations. To these men belongs the credit for much if not all of the development we have noted, a development which now calls for the operation of more than 6,000 central generating plants capable of handling a yearly increase of lighting load equivalent to 100,000,000 sixteen-candlepower lamps, more than one lamp per capita of population of this country. As a point in development it is interesting to know that of the number of incandescent lamps made and sold during 1913, about 60 per cent were tungsten units.

To the manufacturing companies also belongs the credit for making possible what we know today as satisfactory illumination and developing same into a real science. Not until a marked advance had been made in methods of lamp manufacture and the application of light units after well worked-out scientific methods, did we hear of an illuminating engineer, or dream of an organization such as the Illuminating Engineering Society, which has now come to mean so much to the cause of good lighting, and regarded as an impartial promotor of the principles on which satisfactory and efficient illumination must be based.

In 1879 we started with the incandescent carbon filament lamp with a current consumption of about 7 to 8 watts per candle power, a life of about 40 hours, and a lamp cost of from $1.50 to$1.75 for a 16-candlepower size. In the early 80's the 16-candlepower lamp was improved to what was known as the "8 to the horsepower" type with a gradual improvement taking place during the next 28 years, resulting in the production of carbon and metallized filament lamps of from 3.5 to 2.5 watts per candlepower, or on the basis of the old rating, "15 to the horsepower." As the result of developments during the past six years we have the tungsten filament lamp with an efficiency of from 1.0 to 0.5 watts per candlepower. Thus a sixteen candlepower tungsten lamp of today if rated on the old basis would be "38 to the horsepower," and with the same wattage per candlepower as required by Edison's first lamp would last 50,000 times as long, or in other words the present unit may be said to be 50,000 times as good.

In point of progress in lamp manufacture, the development of the year is represented by refinements and standardization of processes and in the perfection and commercial production of the so-called "half-watt or high efficiency tungsten lamp" in 1,000, 750, 500, 400, 300 and 200 watt sizes for use on all commercial circuits with proper design of fixtures and reflectors. The last two sizes were announced just before this issue went to press, and elsewhere in these columns the lamps and their applications are discussed.

As regards refinement and standardization of tungsten lamps in average sizes, it is now recognized that there is no economy and that there is an actual loss to both the customer and lighting company, when lamps are operated under the voltage for which they were intended. In line with these facts, therefore, and to conserve the interests of the lighting company and its customers, manufacturing companies have now abandoned the three voltage rating label, substituting a label with a single voltage. This single voltage corresponds with the high operating efficiency of the three voltage label. With proper attention paid to circuit voltages by the lighting companies, good lamp efficiency is now practically certain, this being the result of an improved quality of tungsten wire and ability to handle the lamp filament with greater accuracy than heretofore.

While it was believed at the time of the conception of the one-half watt lamp in its large sizes that it would take over the street lighting field, this scare has blown over, for it has created new fields in which it seems equally as well suited, such as park illumination, exterior entrance illumination for theaters, amusement parks and the like. In these fields it is believed that it will be more rapidly introduced for the reason that no present apparatus must be replaced. and on account of the basis it furnishes for competing with gas arcs. While this type of lamp is certain to be a dangerous competitor of the electric arc lamp, the field for the arc lamp is far from hopeless with improvements in design that are now being made.

To comment, except in a general way, on the tendencies of any field of lighting at the present time, with developments in lighting units and systems following in such rapid succession, would be mere guess work, especially in light of a statement by a well known authority which says, "I almost hesitate to tell you what the actual efficiency—or I had better say inefficiency—of lighting is, even at the present time. If we should assume an ideal lamp such that all the energy we put into it comes out in light, and in that form which would be most efficient, then on that basis, the most efficient tungsten lamp of the present day would only measure 5 or 10 per cent. The other 90 per cent of the energy is lost so far as light is concerned, and I have to confess that the prospect is not what one would call cheerful of getting much more out of it."

In spite of these facts, there are a few things certain, namely, that the cause of good lighting is advancing more rapidly than ever before; that more light is being secured for the same expenditure of money than ever before; that lighting conditions in connection with industrial operations are receiving more attention than ever before; that the effect of light intensity and direction on the eye is being properly considered, and in short, light is being used more efficiently than ever before in all fields on account of an increased knowledge of requirements and available apparatus. All this is being brought about through the combined efforts of manufacturers of lighting apparatus, engineers, architects and central station companies.

The High Efficiency Tungsten Lamp and Its Application

BY A. L. POWELL, ILLUMINATING ENGINEER, EDISON LAMP
WORKS OF G. E. COMPANY.

Features in Connection With Development and Application of the Newest Lighting Unit.

AT a meeting of the American Institute of Electrical Engineers, held in New York, October 10, 1913, a paper was presented by Messrs. Langmuir and Orange which outlined and discussed certain radical changes and improvements in the construction of incandescent lamps. Since then the features mentioned have been incorporated in the commercial product of the leading lamp manufacturers, and the new type lamp is being used in considerable numbers throughout the country.

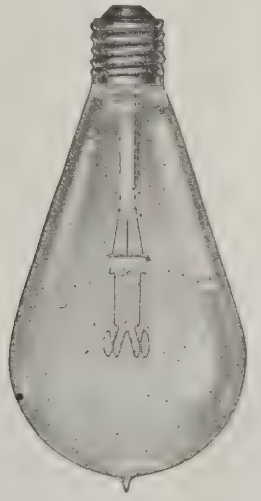


Fig. 1. The High Efficiency Tungsten Lamp.

Although the high efficiency types of lamps were made in the laboratory over a year ago, further investigation was necessary before the lamps were ready for the market and in regular factory production. The 750 and 1,000 watt multiple and a number of street series lamps were announced on March 1, 1914. Since then other sizes have been developed, and the following are now standard:

DATA ON STANDARD HIGH EFFICIENCY TUNGSTEN LAMPS FOR MULTIPLE (105 TO 125 VOLT) CIRCUITS.

Size Lamp	Efficiency w. p. c.	Type and size of Bulb	Bulb Diam. in Inches	Max. Over-All Length in Inches	Light Center Length in Inches *	Base
200	.80	S-30	3¾	7⅞	5 7/16	Med. Screw Skt.
300	.78	S-35	4⅜	8¾	6⅛	Med. Screw Skt.
400	.75	S-40	5	10	7	Mogul Screw.
500	.70	S-40	5	10	7	Mogul Screw.
750	.60	S-46	5¾	13	9½	Mogul Screw Skt.
1000	.55	S-52	6½	13⅜	9½	Mogul Screw Skt.

* Distance from base contact to center of filament barrel.

SIZES OF SERIES HIGH EFFICIENCY UNITS.

5.5 amps., 60, 80, 100, 250 and 400 c. p.
6.6 amps., 60, 80, 100, 250, 400 and 600 c. p.
7.5 amps., 60, 80, 100, 250, 400 and 600 c. p.
15 amps., 400 c. p.
20 amps., 600 and 1,000 c. p.

These lamps operate at various efficiencies, depending on the amperage and candle power. As a general statement, for a given amperage, the higher the candle power the better the efficiency, for there is less cooling effect produced by the heavy leading-in wires. For a given candle power, the higher the amperage the better the efficiency, for with the larger wire the proportionately less heat is taken up by the gas convection currents. The 15 and 20 ampere lamps are intended for operation on standard series circuits using an individual compensator for each lamp, stepping up the current to the required value.

The higher efficiency lamps have all the good features of the vacuum type lamp, for they operate equally well on alternating or direct current. They may be burned in any position, although since such deposit as occurs settles above the filament, it is generally desirable to use the lamp in a pendent position. The life tests indicate a parallel performance; that is, the lamps seldom fall to 80 per cent of the candle power in their rated lives, and the average candle power for 1,000 hours' burning is well over 90 per cent.

Although the filament operates nearer its melting point, severe service tests seem to indicate that there is no more danger of burn-outs through over-voltage than with the former types. The coiled filament, acting as a spring, serves to take up any shocks and makes a particularly sturdy lamp.

The filament being confined within a smaller space than in the vacuum lamp, a somewhat different distribution of light is obtained. A characteristic distribution curve of the 1,000 watt lamp, clear and without reflector, is shown in Fig. 2. The ratio of mean spherical to mean horizontal candle power, or spherical reduction factor, is higher than heretofore, being about 88 per cent.

The new lamps possess marked advantages, as follows: (1) Higher efficiency or greater light output per unit of power input. (2) A whiter light, due to the higher filament temperature, approaching theoretical black body values.

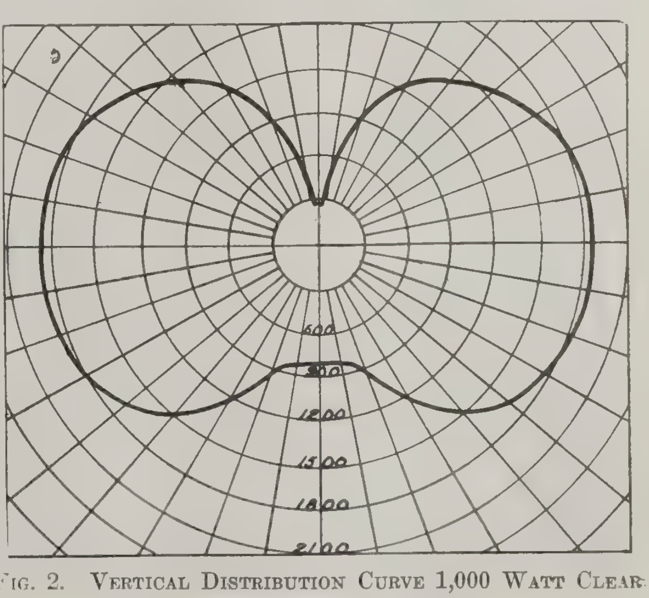


Fig. 2. Vertical Distribution Curve 1,000 Watt Clear Bare Tungsten Lamp.

(3) More powerful than before, and yet not requiring extreme bulb sizes. (4) A more concentrated filament, permitting more accurate reflector designs.

REFLECTORS FOR HIGH EFFICIENCY TUNGSTEN UNITS.

Auxiliary devices have been developed by most of the leading manufacturers for use with these lamps, taking into account the proper location of the light center, and, with the larger sizes, providing adequate ventilation. This feature is important, for a large amount of energy is liberated, principally in the form of heat.

For Direct Lighting. The 400 and 500 watt multiple lamps are applicable in the reflectors previously used with these sizes of lamps, as they have the same light center length. In the case of diffusing glass units, precautions should be taken that the material is sufficiently dense to give adequate diffusion, as the intrinsic brightness of the filament is considerably greater than heretofore. In any open reflector the angle of cut-off should be quite low in order to prevent the light source from being visible.

Porcelain enamel industrial reflectors are available in bowl, dome and angle types for the various sizes. This finish is desirable, as it withstands the heat and suffers on depreciation through long service. Prismatic bowl-shaped reflectors are listed, and are naturally very efficient, as with the small filament area accurate design is possible. Many designs in the larger sizes of opalescent bowl reflectors are directly applicable, and moulds have been developed for special 750 and 1,000 watt reflectors.

Probably the greatest variety of units is found in the enclosing type. Opalescent balls of various sizes, with and without external reflectors, with plain and ornamental housings, are available, meeting almost any condition of out-of-doors service. Most of these have ample provision for ventilation and furnish protection against the weather.

Bell-shaped, two-piece, opal glass fixtures of several patterns are on the market, which give quite satisfactory light distribution, due to the fact that the upper half is usually of a dense glass, acting as a reflector, while the lower portion is of a light density, acting as a diffuser.

The prismatic enclosing unit consists of a pressed prismatic bowl as the upper section, and a satin finish bowl with prisms on the inside covering the mouth of this. This is the most efficient of all the enclosing devices, and is useful where a high utilization is required.

For Indirect Lighting. The one-piece mirrored indirect unit is listed for the new lamps with specially designed reflectors. These are equipped with various decorative housings or ornamental casings, complying with the requirements of the different periods of architecture. The porcelain enamel steel indirect units are generally applicable without change, as they act by diffuse reflection; the change in filament position from the old to the new lamp is not serious. There is no special precaution necessary against heat, as this finish withstands high temperatures.

For Semi-Indirect Lighting. The deep, dense, opalescent glass dishes are generally suitable, provided the fixture used is wired with sufficient capacity to meet the demands of the heavy current. The socket should not be tightly enclosed by a decorative husk, in order that the air may circulate about the base of the lamp. The leaded art glass semi-indirect dishes are especially well suited, as the material is quite dense, and large enough units can be built up so that they will appear in good architectural proportions on the wide spacing necessary with the larger size lamps.

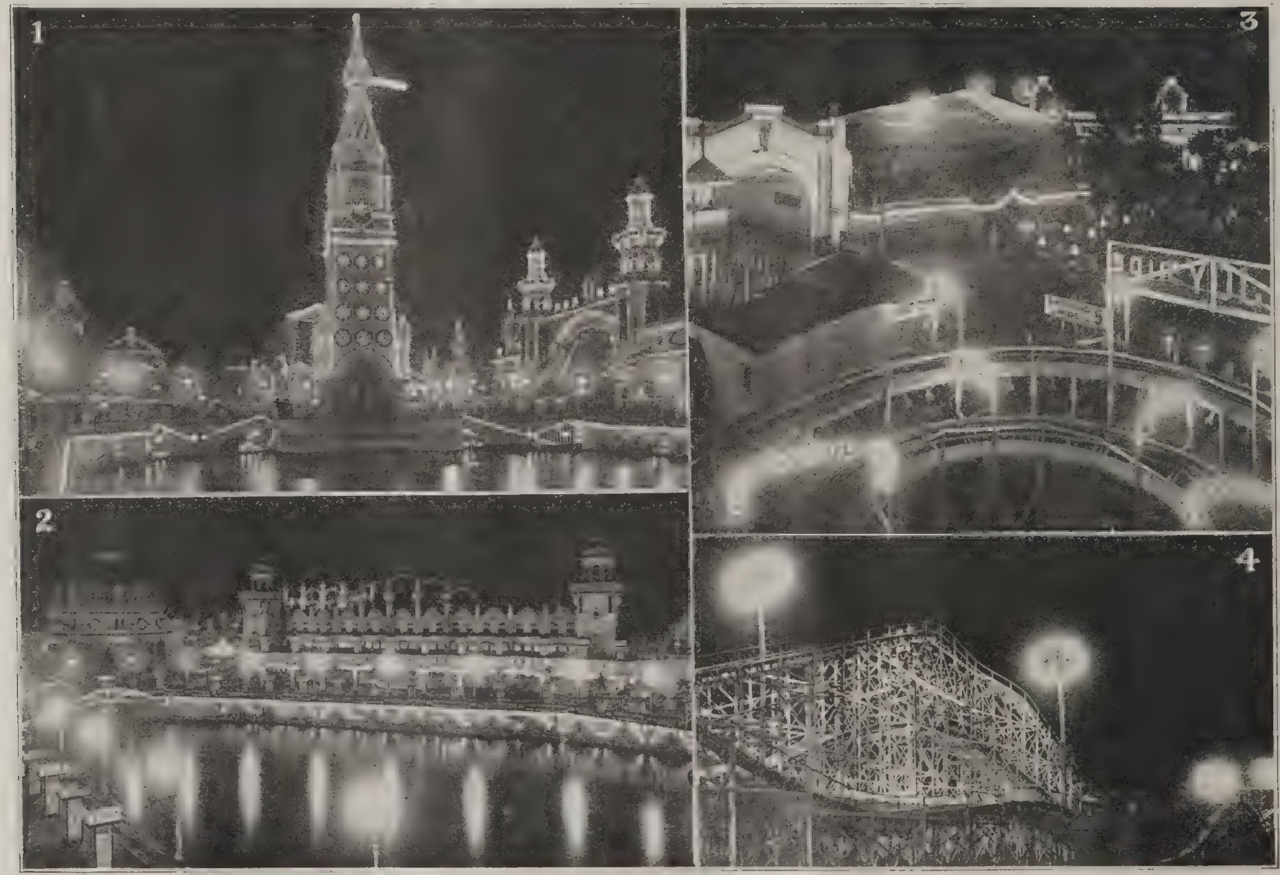


Fig. 3. (1) Night View of Luna Park, Coney Island, N. Y. (2) Luna Park, Coney Island, General Illumination by 750 and 1,000 Watt Tungsten Lamps. (3) White City Park, Chicago, Ill. (4) Roller Coaster at White City Park, Chicago, Ill.

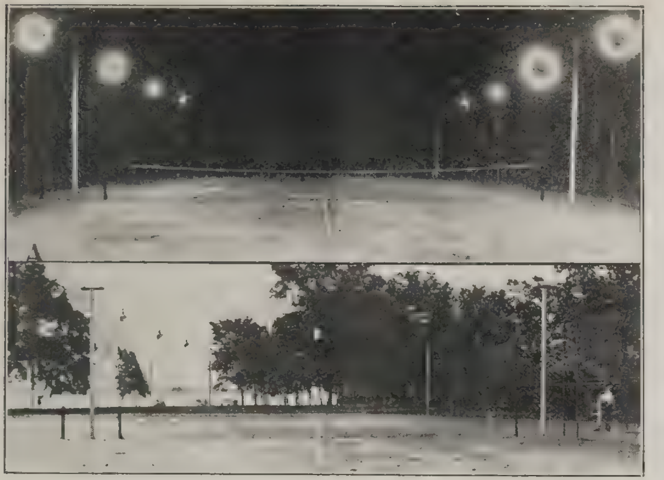


FIG. 4. (1) NIGHT VIEW OF STANDARD TENNIS COURT LIGHTING LAYOUT. (2) DAY PHOTO OF TENNIS COURT ILLUMINATED BY 12-400 WATT HIGH EFFICIENCY TUNGSTEN LAMPS.

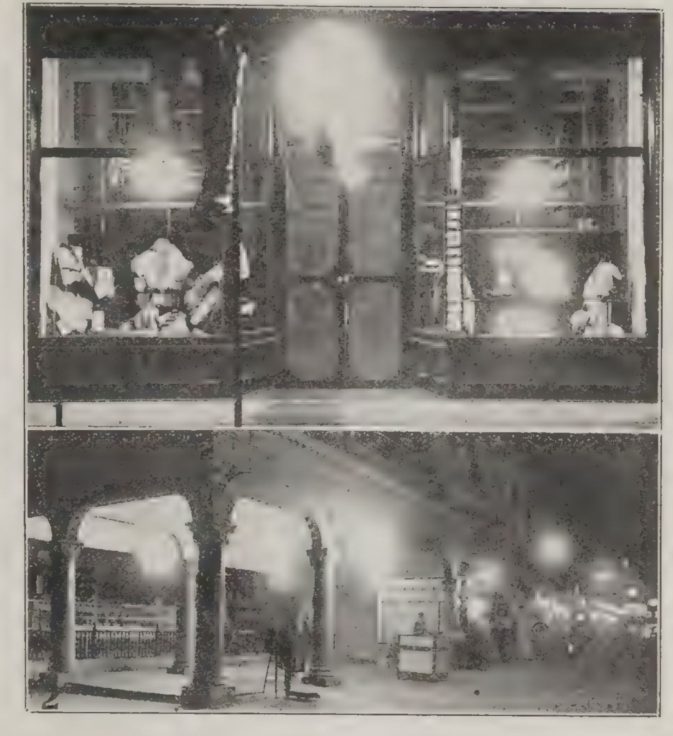


FIG. 6. (1) INADVISABLE METHOD OF ENTRANCE LIGHTING. (2) "ROUGH RIDERS," CONEY ISLAND, N. Y., SHOWING 1,000 WATT TUNGSTEN LAMPS IN WEATHER-PROOF FITTINGS.

A very efficient semi-indirect fixture consists of a prismatic bowl reflector inverted within a light density, white glass stalactite. This gives a very broad distribution of light, and since but a small percentage of the light is transmitted through the inner reflector, the outer casing is not unduly bright.

For Street Equipment. The standard, radially fluted, porcelain enamel reflector is applicable with the smaller size and gives a wide spreading of the light. It should not be used with the higher candle power lamps, as it is necessary to provide some diffusion and also protection against weather.

An almost ideal device is the concentric porcelain enamel diffuser, with a refractor about the lamp. This refractor consists of two pieces of prismatic glass welded together with the ridges on the inside. One set of prisms is vertical and one horizontal. The first set reduces the intrinsic brilliancy, and the second, or refracting set, is designed to concentrate the light at 80 degrees. The outside of the refractor is smooth, and no dirt of any sort can reach the prisms. The small filament of the new type lamps makes it easy to get astonishing results from such an equipment.

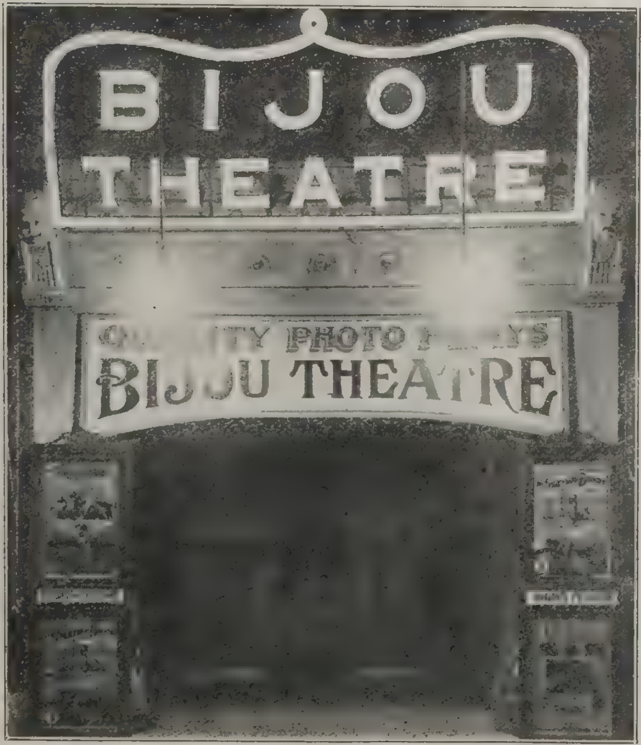


FIG. 5. BUILDING FRONT LIGHTING WITH 750 WATT TUNGSTEN LAMPS.

For instance, a standard series lamp operated at 100 horizontal candle power when bare produces over 200 candle power at 10 degrees below the horizontal when equipped with the apparatus just described. There is plenty of light below the unit, and everyone conversant with the subject of street lighting knows that for most conditions a maximum candle power of 10 to 15 degrees below the horizontal is most desirable.

A number of designs of upright ornamental enclosing globes are on the market for use with various sizes of lamps. These, combined with cast iron or concrete posts, make the so-called "white-way" lighting economical and attractive.

Fixtures are listed for the larger lamps which resemble arc lamps in appearance. Enclosing globes of different contours and external reflectors are standardized, as are also different sizes of metal housings covering the socket and cutout. In the case of the 20 amp. lamp, the compensator is placed within the casing which carries the receptacle.

APPLICATIONS OF THE HIGH EFFICIENCY TUNGSTEN LAMP.

In the following examples of installations an attempt has been made to pick out typical views of the various fields to which the high efficiency lamp is especially applicable, and also to illustrate the use of different reflecting devices. It would be entirely too extensive a proposition to show and discuss all possible combinations. It is to be hoped that these few cases will serve their purpose in suggesting to the reader the kind of service to which these lighting units are especially well suited.

Amusement Parks. A very high intensity of lighting exists here, and the new lamps, with their large flux of light and high brightness, fit in especially well with the general scheme. The lack of maintenance trouble is a good feature, for the electricians employed about such a place are kept sufficiently busy with apparatus troubles and have but little time to attend to lighting. Two night photographs of Luna Park, Coney Island, are shown in Fig. 3. This very famous seaside resort utilizes over 80—750 and 1,000 watt lamps. The standard equipment consists of a spherical, opalescent glass, diffusing ball and weather-proof, ventilated socket covering. The first view shows the appearance of the park with these lamps and all the decorative lighting turned on. The other view, taken across the lagoon, shows the effect produced by the large lamps alone, as practically all of the outline lighting is extinguished.

Another amusement park, White City, Chicago, is shown in Fig. 3. In the background of Fig. 3—(3) the "Maid of the Mist" (a scenic ride) may be seen illuminated by 4—1,000 watt lamps. These are equipped with a fitting resembling arc lamp casings, utilizing a diffusing glass globe and external reflector. The "Roller Coaster" in this park, shown in Fig. 3—(4), is brightly lighted by 12—1,000 watt lamps with equipment similar to that just outlined. These lamps with equipment similar to that just outlined.

Tennis Courts and Athletic Fields. A great deal of interest is now being evinced in the artificial lighting for out-of-doors sports. This is becoming more and more practical through the increased efficiency of the light source. The writer has discussed tennis court lighting a number of times in the technical press, and the general features need not be repeated. The high candle power lamps are being utilized in a variety of arrangements for night tennis playing. Some courts are equipped with 4—1,000 watt lamps in bowl-shaped steel reflectors, suspended in a row, high over the center of the court. Others use 8—750 watt lamps in angle steel reflectors on posts at the sides of the court.

A day view of an arrangement which is very satisfactory is shown in Fig. 4—(1). Here 12—400 watt high efficiency lamps are used in porcelain enamel angle steel reflectors. These are suspended by weather-proof hangers from messenger cable. The lamps are about 14 feet above the ground and 6 feet back from the side lines. A night view of this court is to be seen in Fig. 4—(2). Plenty of light is provided on the surface of the court and well up in the air, so that the highest lobbed balls never pass from sight. Illumination tests indicate a very even distribution of light, using this system, and surprisingly fast tennis is possible under the artificial lighting.

Building Exteriors. These may be illuminated in two ways: By projected light or by lamps suspended from the building itself. The first method is very striking, particularly where the bright building is contrasted against a dark background. When the light is properly applied, the structure stands out in dignified relief. The standard high efficiency lamps, with their semi-concentrated filaments, can be used in parabolic shaped reflectors to produce quite powerful beams. Other lamps are manufactured with filaments especially concentrated, which, in true parabolic reflectors, become intense searchlights. A number of such equipments may be located inside of or on the roofs of adjacent build-

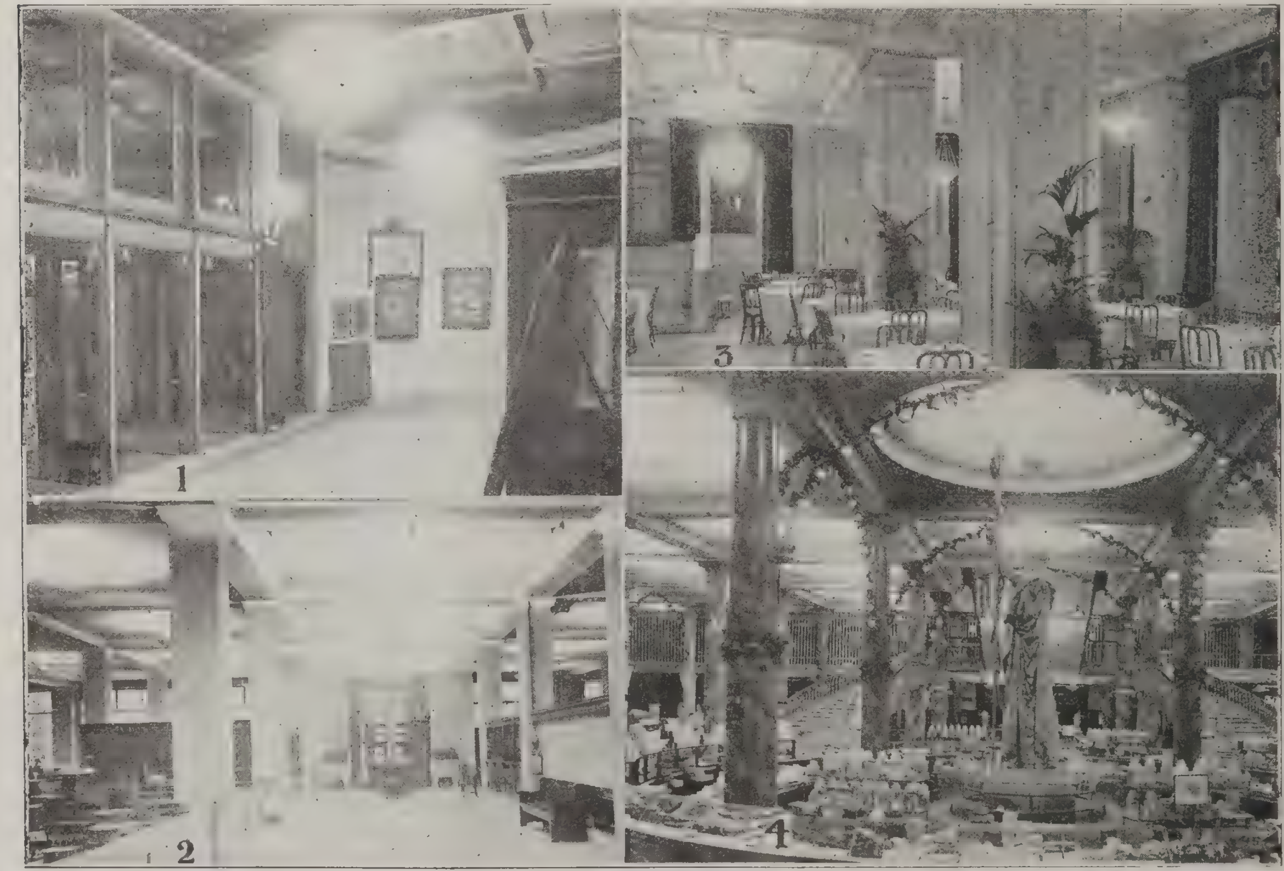


Fig. 7. (1) Semi-Indirect Illumination as Applied to a Theater Lobby. (2) Office Lighting With Totally Indirect Units. (3) The Dining Room of the Windsor Hotel, Wheeling, W. Va. (4) Night View of J. B. Greenhut Store, New York City.

ings and the light trained on the structure to be illuminated. A little experimentation will show the proper placement of the light sources and the amount of light required. This last factor will, of course, depend on the color of the building and the intensity of illumination in the vicinity.

Display front lighting, while not quite as high class as the lighting from concealed sources, has considerable advertising value. The crowd will involuntarily be drawn to the neighborhood of the bright lights. It is simple and inexpensive to install this type of lighting.

An installation typical of the smaller building is shown in Fig. 5—a motion picture house at Atlantic City, N. J. Two 750 watt lamps in spherical enclosing globes with weatherproof housing are hung at the end of long pipe brackets, brightly illuminating the face of the structure and the attached signs.

On the Commonwealth new fish pier at Boston, a total of about 50—750 watt lamps are required for the exterior illumination. These are fitted with ornamental weatherproof fixtures with opalescent glass diffusing globes. Not only is the architecture of the building visible, but the driveway and adjoining streets are well illuminated.

Entrance Lighting. This is very closely related to the exterior illumination of buildings, and has the same effect of drawing the passerby to the objective point. As the lamps are likely to be hung low, special attention should be paid to the diffusion. For example, Fig. 6—(1) shows a feature which is to be avoided. In this case a 750 watt lamp, equipped with a relatively flat porcelain enamel reflector is located directly above the entrance and but about 10 feet from the ground. The glare from such a condition is severe. Although the bright light will attract some attention, such practice is to be discouraged.

In contrast to this is the installation at the entrance to the "Rough Riders" attraction at Coney Island, illustrated in Fig. 6—(2). Although a considerable number of 1000 watt lamps are used, they are hung high and equipped with opalescent glass globes. The standard of illumination in the vicinity is high, and since the eye is adapted to the bright lighting, such an installation is not the least uncomfortable.

The lobby of the Colonial Theater, Chicago, Ill., (Fig. 7—(1), has a very attractive lighting system. Semi-indirect fixtures with leaded art glass bowls are fitted with 1000 watt lamps. The design is very neat, and as the glass is dense, no glare is produced. The entire space is brightly and uniformly lighted.

Offices and Drafting Rooms. Modern practice is tending toward a universal adoption of a high intensity of well diffused, evenly distributed general illumination from overhead sources. Local desk lamps are being rapidly done away with. If the ceiling of the building is light in color and not badly broken up by trusses and beams, indirect or semi-direct lighting is especially well suited for this class of service. Five hundred and 1000 watt lamps are used in the office shown in Fig. 7—(2). Porcelain enamel, totally indirect fixtures with a decorative casing, serve to direct the light from the lamps to the white ceiling, from which it is diffusely reflected to the desk level.

If the ceiling of the room is high, and yet too dark or broken up for indirect systems, the high efficiency lamp may be used for direct lighting. A high ceiling is necessary, however, to permit economic spacing of the high candle power lamps, and also to keep the lighting units well above the field of vision. With a low ceiling the smaller lamps should be spaced fairly close.

Decorative Interior Lighting. This group includes churches, hotels, theaters and the like. For this class of service, the present tendency seems to be toward semi-indirect and totally indirect lighting, using ornamental fixtures. These systems of lighting have been made much more practical with the introduction of the higher efficiency lamps, placing them well within the reach of everyone. The good qualities of indirect lighting are appreciated by all who are familiar with lighting practice.

Mention has already been made of the use of art glass semi-indirect fixtures. A very pleasing installation of this

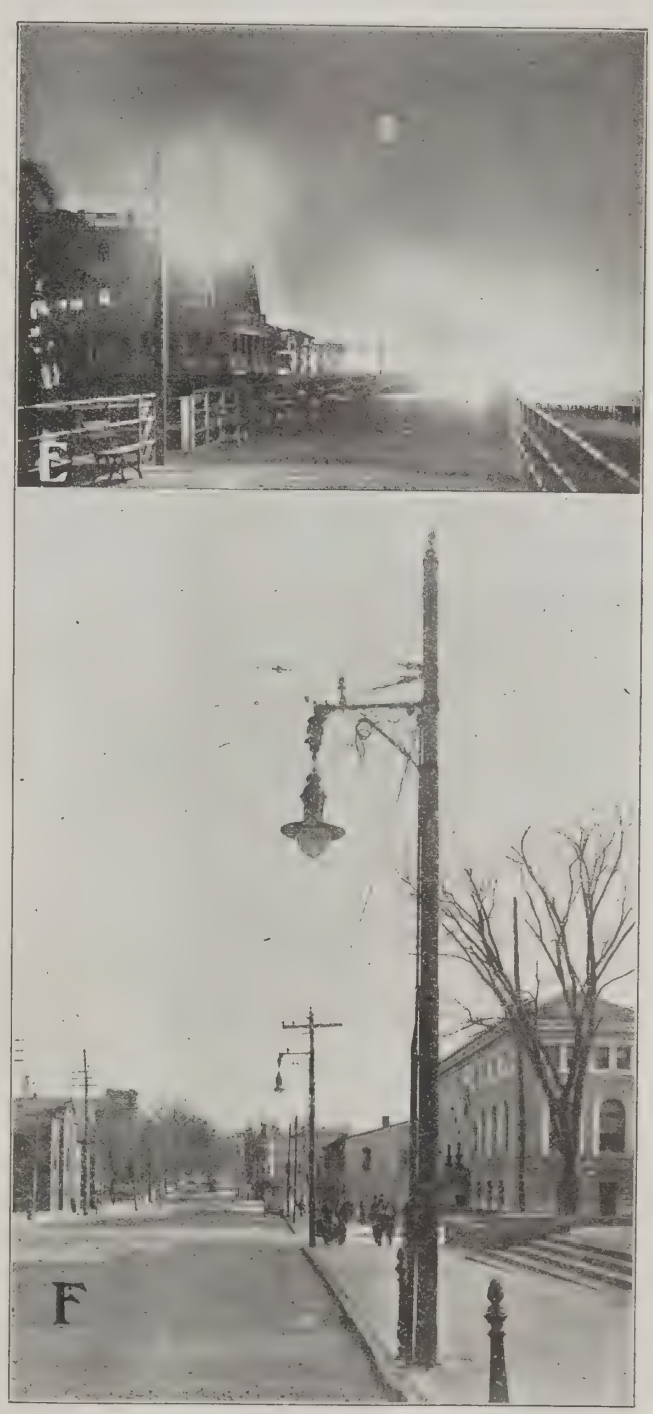


FIG. 8. (1) SIXTY CANDLE POWER HIGHER EFFICIENCY TUNGSTEN SERIES LAMPS USED FOR LIGHTING THE BOARD WALK. (2) DAY VIEW OF INSTALLATION COMPENSATOR ENCLOSING UNIT.

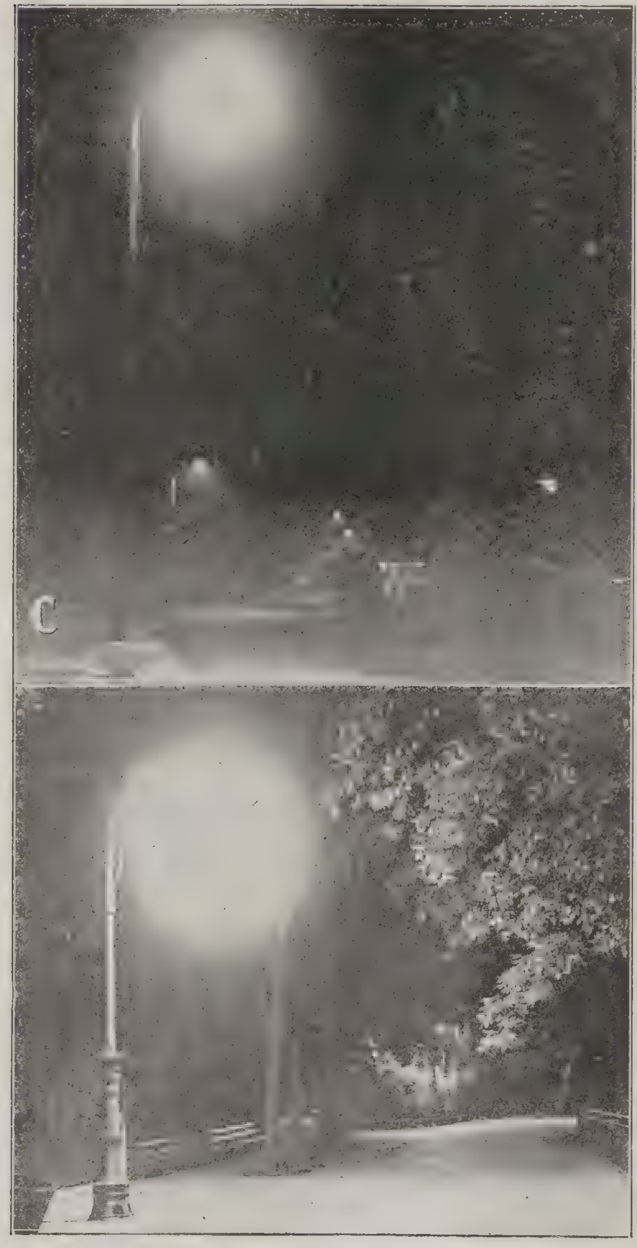


Fig. 9. (1) High Candle Power Lamps Used for Illuminating Loading Platform in Freight Yard. (2) A 1,000 Watt Multiple Lamp Used to Illuminate the Walk About the Animal Cages, Lincoln Park, Chicago, Ill.

nature is shown in Fig. 7—(3), which is a night view of the dining room of the new Windsor Hotel, Wheeling, W. Va. The fixtures in themselves are things of beauty, designed by Cassidy & Sons of New York. Four hundred watt, high efficiency lamps furnish a soft, restful, illuminating effect. Glare is not to be found and yet there is enough directional effect to the light to avoid any appearance of flatness. The metal work of the fixtures is carefully planned and in good harmony with the room treatment.

Dry Goods and Department Stores. This class of service has continually demanded a light which approximates daylight in color. The original types of incandescent lamps had far too great an amount of red in their emitted light to make them generally applicable for the higher grade of store. The tungsten lamp, however, with its greater efficiency and improved quality of light has rapidly come into prominence for store lighting. The enclosed arc, although its color was somewhat better, soon gave way to the tungsten lamp. It was therefore to be expected that the new lamps would be rapidly adopted, for they give still greater economy and a whiter light.

Most of the large stores are divided into bays. Although these vary in size there is a suitable range of lamps to give the proper watts per square foot, using but one outlet per bay. This arrangement cuts down the cost of wiring and does not give one the impression of entering into a forest of fixtures. Indirect systems are coming more and more into prominence, and as most stores have very clean and light colored ceilings, the cost of indirect lighting, using the high efficiency lamp is not in the least prohibitive. Fig. 7—(4) shows the appearance of the main floor of the J. B. Greenhut Company's store, New York, where 400 and 750 watt high efficiency lamps are used with totally indirect porcelain enamel steel reflectors. The illumination is of a high intensity but evenly distributed and most agreeable.

The new lamps when used for direct lighting should usually be provided with totally enclosing globes to avoid any possibility of annoyance. Although the 1000 watt lamps used here are hung moderately low, the effect produced is gratifying, and the store managers are satisfied with the installation.

Special light blue enclosing globes are on the market, which, when used with these lamps, give a very close approximation to white light. Due to the better color of the light emitted from the lamps themselves, this method of lighting is not unduly extravagant. Accurate color matching units are available for lighting small areas, which also employ the subtractive method for obtaining the result sought.

Streets. A complete discussion of this phase of illumination is far beyond the scope of this article, so that a brief outline only is possible. The lower candle power series lamps are especially suited for the lighting of residential streets, country highways, the less congested business sections, board walks and the like. The spacing will, of course, vary with the density of traffic, but in general the units are quite widely separated. Reflectors must be used which give a broad distribution of light. The refractor equipment described above is exceptionally well suited to this service. The use of radially fluted, porcelain enamel steel reflectors with 60 candle power higher efficiency tungsten lamps is shown in Fig. 8—(1). This is of the board walk at Ventnor, N. J. Here the lamps are about 15 feet above the walk and spaced approximately 200 feet. Plenty of light is provided at all points, although somewhat more even distribution would have been secured by using the double street refractor.

The higher candle power lamps are adapted to the lighting of prominent business streets, main thoroughfares, and for use in the so-called "white-way" sections. A day view of one of the many equipments which have been developed for this class of lighting is shown in Fig. 8—(2). An ornamental metal casing protects the receptacle, compensator and cutout, as well as supporting the opalescent glass diffusing ball and external porcelain enamel reflector. Six hundred candle power, 20 ampere lamps are used. Since this type of equipment is spaced quite closely, an extremely broad distribution is not vital. It is quite evident that the street and sidewalk are brightly and evenly illuminated.

Yards, Passageways and Erection Work. This class of outdoor lighting differs somewhat from ordinary street illumination as a fairly high intensity is required over a restricted area. In general the units will be suspended from poles, either permanent or temporary. The type of fixtures used will vary with the conditions: For instance, in Fig. 9—(1) we have a night view of the walk about the animal cages in Lincoln Park, Chicago. Here appearance is quite essential as the equipment is in the view of the general public. In this case a 1000 watt multiple lamp is used with fittings similar to those shown in the second preceding cut.

Another condition is shown in Fig. 9—(2), which is from a photograph taken of the loading platform in the freight yards of the Pittsburgh and Lake Erie R. R., at Pittsburgh, Pa. This particular view shows 4—1000 watt lamps spaced about 100 feet apart. They are equipped with deep bowl, porcelain enamel industrial steel reflectors and weatherproof socket holder. This reflector sends all the emitted light downward in a very efficient manner, distributing it over quite an area.

For erection work, excavating and the like, the industrial reflectors are suitable. Where vertical surfaces are to be lighted, the symmetrical or angle reflector, arranged to send the maximum light in the desired direction, is especially well suited.

Such an outline as given above might be continued cov-, ering all the classes of buildings to which the larger lamps can be applied. For instance, high interiors, such as armories, waiting rooms, exhibition halls, gymnasiums, railway stations, waiting rooms, concourses and similar edifices are all suitable for direct lighting with this type of illumination. The equipment used will vary with the conditions and may be either ornate or simple. Where the fixtures are hung very high, special precaution should be taken to avoid any danger from falling glass.

Industrial plants of all sorts offer splendid opportunities for utilizing this improved form of incandescent lamp. Dome or bowl shaped steel reflectors can be installed above the craneways, or angle reflectors may be located below the crane tracks at the sides of the bays. As most of the industrial plants in which the high candle power lamps will be used have lofty ceilings and the lamps can therefore be suspended well up, special diffusing media are not necessary. Other uses will readily suggest themselves, as, for instance, the illumination of any sort of interior from lamps located above a skylight. Reflectors which are very efficient and which give a strong directional effect, would be necessary here.

It may be well in closing to suggest that great care be taken in utilizing these lamps, no matter for what class of service they are used. Either hang them high enough to be well out of the field of ordinary vision, or use equipment which diffuses the light and thus reduces the brillinacy.

Socket Voltage and its Effect on Lighting Service

BY M. D. COOPER, ILLUMINATING ENGINEER, ENGINEERING DEPARTMENT, NATIONAL LAMP WORKS OF G. E. CO.

WHEN a consumer buys electric light, supplied by means of incandescent lamps, the cost of light is made up principally of two items—the cost of energy and the cost of renewals. That is he is required to pay a monthly bill for power and to buy new lamps when the old ones burn out. Cases are not infrequent where a consumer will point with pride to the lamp that has burned for two or three years and will place his stamp of approval upon such a lamp as being one of the finest ever made, probably with some remark to the effect that, "it is too bad they don't make them as good as they used to." The theory of such a consumer is that long life is the real criterion of lamp quality. It is the purpose of this article to disprove this fallacy, for it is a fallacy, and to show that it is not economical to use a lamp in such a manner that it will live for a period as long as that referred to. Further, it will be shown in such cases that the customer has been paying more for the amount of light he has received than it would have cost him to renew the lamp many times over. The reason for this is that the lamp referred to has either burned at a voltage lower than its rating or else the voltage rating of the lamp was lower than the quality of the lamp justified.

The voltage at which a lamp operates is the one condition upon which the over-all economy of light production is dependent. When a lamp is burned at a voltage higher than its rating, its life is shortened but its efficiency is increased. In other words, renewal expense becomes higher and the cost of energy per candle power becomes lower. On the other hand, when a lamp is operated at a voltage lower than its rating the life becomes longer but the lamp operates less efficiently. Economical operation therefore is obtained only by arriving at a proper balance between these two factors—cost of renewals on one hand and cost of energy on the other.

For example, to take an extreme case, a Tungsten lamp may be operated at the same low efficiency as a carbon lamp if it is burned at a voltage 37 per cent below its rated voltage, when it would probably live indefinitely. In such a case, however, it will readily be seen that by such operation the advantage of the higher efficiency of the tungsten lamp will be lost entirely. Thus when the degree of undervoltage burning is narrowed down to such limits as are encountered on ordinary circuits, the loss due to undervoltage burning is not so obvious but just as real.

The voltage rating which the manufacturer places on an incandescent lamp represents an economical balance between efficiency and life. This rating means that for all oridnary conditions, the lamps will not produce light as economically as possible if they are burned at a voltage lower than that indicated by such rating. Lamp ratings are so designed that as an average for all costs of current on which the lamps may be operated, a proper balance between energy cost and renewal cost is secured. For this reason, and also because improvements in quality do not always result in immediate increases in efficiency, the ratings on lamps are generally lower than the most economical voltage and for this reason it is often advisable to burn the lamps at a voltage higher than their rating.

Investigations have shown that a very large proportion of the incandescent lamps used throughout the county are burning undervoltage. This may be due to any or all of a variety of causes such as: Too much voltage drop on either primary or secondary lines; unbalanced load on three-wire circuits; the addition of new business without proportionate increase in the size of the transformers, etc.; and errors in switchboard instruments.

To show the importance of attention to the matter of voltage drop in connection with a lighting installation, let us examine the effect of such voltage drop upon various characteristics of an installation. A decrease of one volt at the terminals of a 110-volt lamp will cause:

(a) A decrease in candle power of 3.5 per cent.
(b) A decrease in wattage of 1.5 per cent.
(c) A decrease in efficiency of 2 per cent.
(d) A decrease in renewal expense of 15 per cent.

The decrease in renewal expense, at first glance, looks to be a very large factor in determining the economy of producing light, but it is really not so important as it might seem, for although it is a large percentage, this relatively large percentage applies to a very small quantity in dollars and cents. A 40-watt lamp during its 1000 hours rated life will consume $4.00 worth of current at 10 cents per kilowatt-hour in producing light. The lamp costs the customer 30 cents, making the total cost of producing light from this 40-watt lamp, during 1000 hours $4.30.

Taking the percentages as above, showing the effect of decrease of 1.0 volt at terminals of 110-volt lamps, we find:

(a) Loss in candle power, 3.5 per cent on $4.30 equals 15 cents.

(b) A decrease in wattage consumed, 1.5 per cent on $4.00 equals 6 cents.

(c) An increase in lamp life, 15 per cent on $0.30 equals 4.5 cents.

Adding (b) and (c), we find the total cost saving to the customer to be 10.5 cents, whereas the cash equivalent of the loss in amount of light received is 15 cents. This leaves a net loss of 4.5 cents to the customer, owing to the fact that this 40-watt lamp is operating 1.0 volt under its rated voltage.

Undervoltage operation affects not only the economy of light production but the economy of operating other electrical devices as well. If the voltage at the consumer's socket is not as high as that which he orders his lamps, etc., the electrical service rendered by the central station will not be up to par. Undervoltage operation therefore benefits neither the consumer nor the central station. The consumer gets less light from his lamp than its rating would indicate and pays for this at a higher cost per candle power than he would if a lamp were not operating below its rated voltage. The central station loses the additional wattage consumption which would be entailed by having the socket voltage as high as the rating of the lamp. The table given in paragraph five of this article shows in a general way the extent of benefit both to consumer and central station.

From the standpoints of the quality of its service, the satisfaction of its customers, and its own revenue, it is therefore very important for the central station to maintain on its lines a voltage at least no lower than the voltage ratings of the lamps and accessories used thereon. From the standpoints of the satisfaction derived from the use of lamps and accessories and the economy of their operation, it is important for all users of such devices to see that their

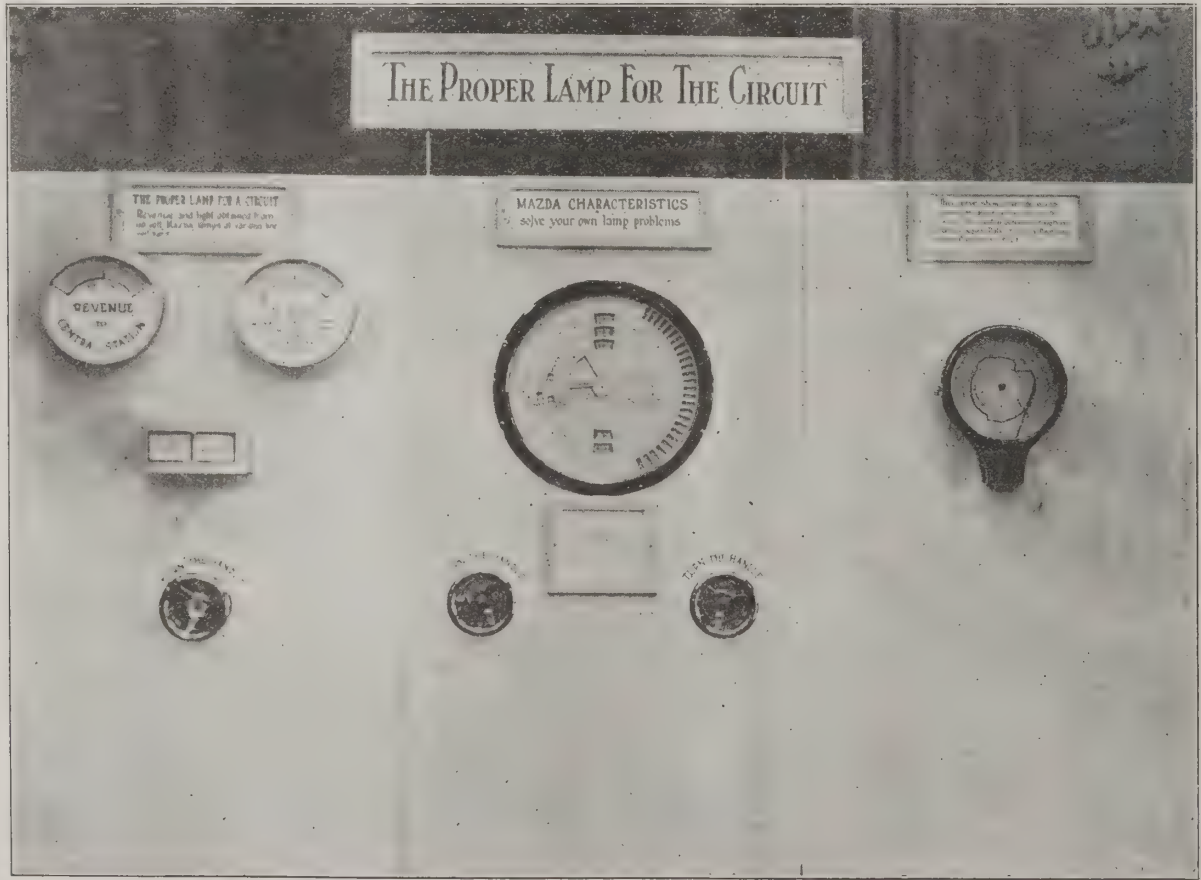

THE PROPER LAMP FOR THE CIRCUIT
THE PROPER LAMP FOR A CIRCUIT
MAZDA CHARACTERISTICS
solve your own lamp problems
REVENUE TO CENTRAL STATION
TURN THE HANDLE

Fig. 1. Arrangement to Show Effect of Voltage Variation on Lamp Operation and Revenue.

voltage rating is, at the most, no higher than the voltage of the circuits on which they are to be used.

At the Philadelphia convention of the National Electric Light Association, the three panel switchboard shown in Fig. 1 was exhibited, arranged with automatic scales in such a manner that by manipulating the rheostat handles the spectator could solve the lamp problem of his particular central station. The first panel of the switchboard showed the relation between lamp voltage, central station revenue, and quantity of light to the consumer relative to cost, and pointed out that the consumer, as well as the central station, loses by undervoltage operation. The second panel showed a computer whereby any lamp problem could be figured out for any energy rate or size of lamps. The third panel showed by an adaptation of a recording voltmeter the degree of undervoltage found by investigation to exist throughout the United States, and it was shown that the number of stations operating undervoltage exceeded the number of stations operating overvoltage in a ratio of six to one.

A mammoth Grandfather's clock was also used to show the loss in revenue due to undervoltage operation of lamps. By means of an automatic mechanism in the head of the clock, a penny was dropped every four seconds into a can labeled "waste" at the bottom of the clock. This, it was shown represented the loss in revenue to a central station supplying a town of 200,000 people and whose lamps averaged four volts undervoltage. Needless to say, it was but a short time before the can in the base of the clock was running over and, literally, piles of money covered the whole base of this big clock. The hands of the clock were ingeniously used to show respectively the rate at which the station meters are moving in the case assumed, and the rate at which they would move if the voltage of the lamps were brought up to normal.

Engineering Considerations When Planning Lighting Installations.

BY J. B. JACKSON, ILLUMINATING ENGINEER, COMMONWEALTH EDISON CO., CHICAGO, ILL.

Suggestions and Data of Interest to Designing Engineers and Architects.

THE engineering in connection with planning and installing lighting systems, while commanding the attention of able electrical engineers and scientists, is yet so new in many of its phases as to be almost entirely empirical. New data is however being gradually collected and formulated which when used according to the interpretation of those engineers giving the matter special study will bring about physical results that will impress the layman and property owner with the economy and desirability of recognizing illuminating engineering as a thoroughly practical science ranking equally with other recognized branches of engineering and demanding attention worthy of the time of those who are capable to produce the illuminating results required by the different classes of operations carried on inside of buildings, as well as results essential to proper street and display lighting. In what follows, some pertinent remarks and considerable data are presented which emphasize the above remarks for the author shows that methods of planning lighting installations have been the result of a gradual evolution of different illuminants and the introduction of new units of higher illuminating value. He emphasizes the fact that to obtain definite and predetermined results in interior lighting it is necessary to know the general schemes of decoration, thus bring the engineering work in close relation with that of the arhcitect. The information presented here is abstracted from a paper delivered by Mr. Jackson at a joint meeting of the Chicago section of the Illuminating Engineering Society and the Chicago Architects' Association and refers to interior illumination only.

In planning a lighting installation the author states that the question which naturally arises is how to determine the amount of light on any surface and how to obtain a measure of the light required for certain classes of service. This he explains as follows. If we can imagine that light is radiated from a source in the form of rays which for purposes of illustration may be considered as analogous to fine wires, and let some surface intercept a portion of these rays, it is evident that the number of rays which fall on a unit area represents a measure of the flux density or the density of the light rays upon the surface. If a standard be chosen which will represent a certain flux density then it is possible to measure by means of photometric apparatus any flux value in terms of this standard. This standard has been given the name of foot candle and should be considered as being independent of the source of light and the distance from the source and as being only a measure of the density or intensity of the illumination produced.

Suppose an observer place himself in a position before a desk with a printed sheet of standard size type and we vary the illumination upon this sheet and when the illumination has reached a value which satisfies the observer a measurement is taken. By taking a series of these readings and obtaining an average value it is possible to state that for that observer the intensity value obtained may be considered as satisfactory for that class of service. These values vary in different observers as much as 5 to 1. The following table gives the values in foot candles for different classes of service and have been obtained by persuing methods which are similar to the one described above, that is, an average value has been obtained in some installation which has been classed as satisfactory. It has often been stated that one system of lighting requires less intensity than another but there is not sufficient authoritative data along this line to warrant any such assertion. Regarding the most recent tests, the U. S. Postal Car Specifications contain the requirements that the illumination shall be not less than 2.8 foot candles, in parts of a car used for reading letter addresses, this value being comparable to the requirements for desk and office purposes. Relative to intensities required there seems to be considerable tendency to require more and more light. In other words our standards are raising gradually, probably not due to any change in the human eye but more likely because ample illumination is more easily and cheaply available. It will be noted that the values given in the table are in ranges, such as 2 to 4 foot candles; being given in this manner to allow some opportunity for the designer to make a choice according to his knowledge of the service required. Values given in the table are average for the entire room.

There are two classifications of fixtures for interior illumination in general use at the present time, namely, ceiling and bracket. Of these an inspection of Fig. 1 will show that ceiling is much more efficient as a lighting unit. With the spacing of ceiling outlets placed in the center of approximate squares we approach the nearest to the condition of uniform illumination which for some purposes is considered to be ideal. The use of bracket fixtures for general illumination is not to be recommended and should be used only when some consideration is given to special or decorative features. In commercial work, it is safe to state that the bracket fixture has very limited application. The fixtures of this type have often been installed and the reason for doing so advanced that they can be used for connection fans, portable lamps, etc. This is not to be encouraged as base-board and floor receptacles make a much more convenient and sightly connection and as a general rule at a cheaper installation cost. If sufficient capacity were installed for bracket fixtures for general illumination the center of the room would be darker than near the walls. Under these conditions objectionable glare almost always is introduced as the usual bracket is much too low for use under these conditions.

As stated above the most even distribution of light is obtained by the use of ceiling units spaced in the center of squares or rectangles approaching squares. The size of these squares are determined by the architectural features of the building such as dimensions of bays and ceiling height. Table 3 shows desirable sizes of squares for location of ceiling outlets under different heights and for different classes of buildings.

The collection of dust and dirt affects different reflectors in varying degrees as is shown by Fig. 2, which is presented by the courtesy of the National Lamp Works, and shows results of tests in Cleveland. The vertical scale representing per cent of the initial illumination value and the horizontal scale the time elapsed in weeks. Curve A represents the results obtained from a dome shaped enameled steel reflector; Curve B, a bowl shaped reflector of the same material; Curve C, a heavy density opal glass. Curve D, prismatic glass; Curve E, light density opal. In referring to opal glass in terms of its density it must be remembered that the term density refers to optical not physical density and is also independent of the thickness of the glass. The lighter density the opal, the higher is the light transmission value. The prismatic glass used in the test was the type which is familiar to all, consisting of a reflector of clear glass with carefully designed prisms on the exterior surface.

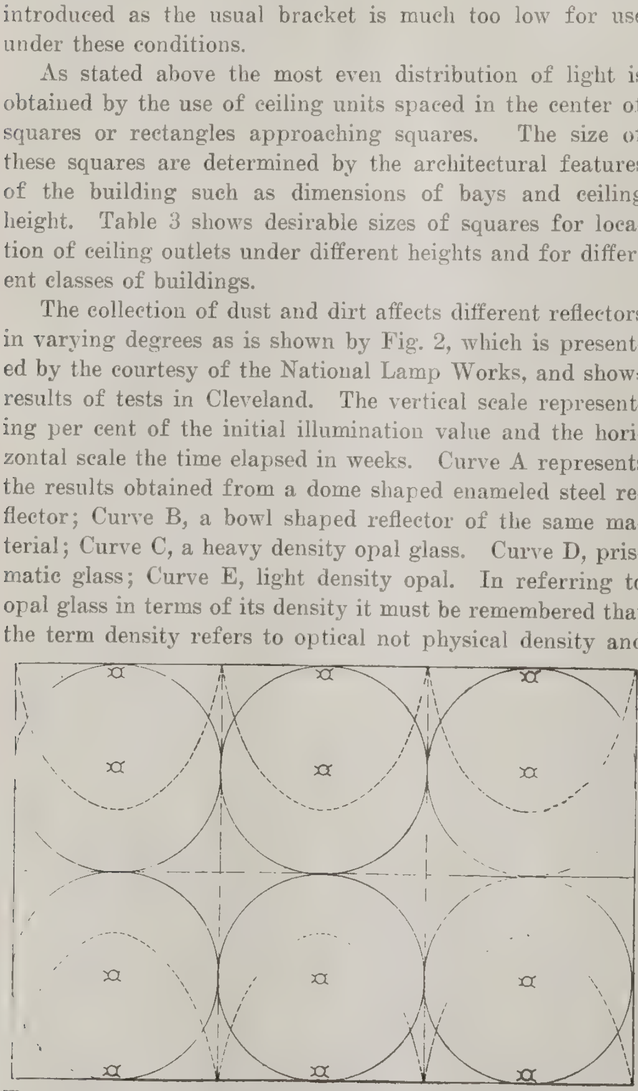


FIG. 1. ILLUMINATION FROM CEILING AND BRACKET FIXTURES—DOTTED LINES FOR BRACKET TYPES.

Contrary to the general belief, these tests show that prismatic glassware is not affected by dirt to as great a degree as is the light density of opals. Under this latter classification will come the most of the opal glass which is being used commercially. These tests did not include any figures on indirect lighting but it has been stated, as a result of tests made at Armour & Co.'s office at U. S. Stock Yards, Chicago, that the figures of 10 per cent a month holds for at least the first two months when mirror reflectors are used. As this last figure corresponds fairly well with results on the curve it would indicate that the position of the reflector has not as great bearing as has been supposed. If we would set 15 per cent as the allowable depreciation on lamps and reflectors the cleaning period would be six weeks for indirect; prismatic, light and medium density opals; and 16 weeks for steel and heavy density opals.

The architect can accomplish a great deal by impressing upon his client the necessity of regular cleaning periods. It is not uncommon that installations have been known to be allowed to go without cleaning for a period of more than a year. This installation might give only 25 to 50 per cent of its initial value, as the equipment used was light density opal which is affected the most of any of the reflector types shown.

In referring to systems of lighting, three terms have come into general use, direct, semi-indirect and indirect. The lines of demarcation between these classes are rather hard to draw, but present definitions are about as follows: The term direct lighting is applied to systems in which a large part and in some cases all of the illumination on the working plane is received directly from the lighting units (lamps and their equipment); indirect when no light is received directly but is obtained by reflection from ceilings and walls; and semi-indirect when only a part is received directly, the greater percentage being obtained indirectly.

In Figs. 3, 4 and 5, curves representing the distribution of light about the unit of three different systems are shown. The curve of the bare lamp being shown dotted in each case serves as a method of comparison.

Inspection of these curves show that the light which we obtain on the working plane is composed of three parts, the light received directly from the unit, plus a portion of that directed toward the walls, plus a portion of that directed toward the ceiling. It is evident therefore that color of walls and ceilings very materially affect the total illumination, as color is an indication of the absorption of light, that is, the darker the color sensation the higher the absorption value; the exception to the above rule being units which direct practically all of the light toward the working plane.

In planning a lighting installation it is essential to consider all the quantities which affect the illumination results, namely, architectural features, intensity required, kind of lamp (such as tungsten incandescent) type of accessory equipment, decorations, etc. In order to simplify matters as much as possible a table has been made up containing all these variables excepting the intensity required for the service. In doing this it has been necessary to assume a lamp for general use for this purpose, the 100-watt tungsten of the January, 1914, rating has been selected.

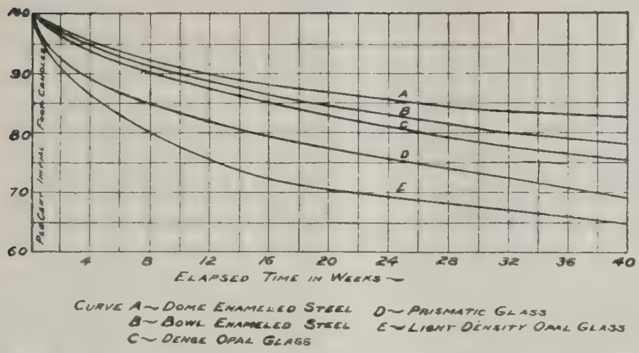


FIG. 2. EFFECT ON ILLUMINATION INTENSITY DUE TO DUST ON LAMPS AND REFLECTORS.

In making cálculations an average lamp depreciation of 3.6 per cent has been allowed for. However, the large sizes of lamps will give somewhat higher results while the smaller sizes will give lower, so for the exact values of lamps other than the January, 1914, 100-watt tungsten multiply results in the table by the quantity under multiplying factor in the table of "Lamp Values," in Table 1.

Below Table 4 three colors are given under each of the classifications, Light, Medium and Dark. These are given as a guide for classifying the different conditions of ceiling and walls. The data shows figures of three decimal places however, no significance should be attached to the last place.

As an example of the method of calculations, assume the following conditions: Width of space, 40 feet; Length of space, 60 feet; Ceiling height, 11 feet; Ceiling color, light; Wall color, medium; Service requirements, general office; Illumination without desk lamps; Type of the equipment, medium density opal; Area, 40 x 60, 2,400 square feet.

From Table 3 a 10 ft. spacing of units is the best adapted for the given ceiling height and dimensions of the space considered. From Table 4 the constant for medium density opal with light ceiling and medium walls is .235 watts per square foot required to produce one foot candle illumination. From Table 2 the intensity required for office purposes under the conditions named is 4.0 foot candles.

Then the number of units is 24; Area per unit, 100 sq. feet; Intensity value × constant equals watts per square foot, 4.0 × .235 = 94 watts per square foot. Depreciation 15 per cent. Then .94 × 1.15 = 1.08 watts per square foot to be provided and 1.08 × 100 = 108 watts per outlet.

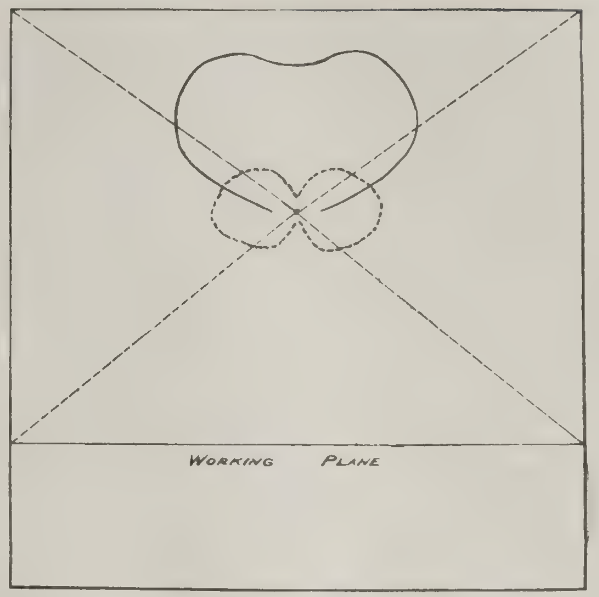
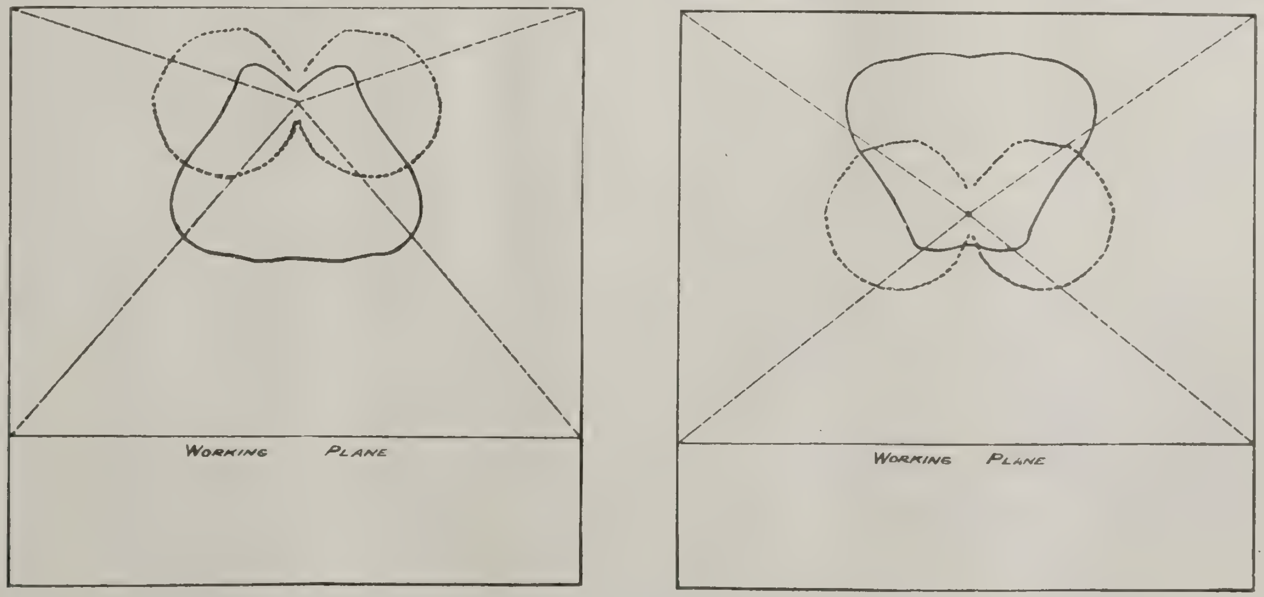


FIG. 5. DISTRIBUTION CURVE FOR INDIRECT LIGHTING UNIT.

As an example of the use of other types of incandescent units if it were desirable to use candelabra carbon lamps, reference to Table 1 shows that the 100-watt value obtained when using tungsten lamps must be multiplied by a constant tabulated in the last column namely, 3.10 from which it is evident that to obtain the same illumination results it is necessary to use 310 watts in the lamps designated.

Relative to the final design of lighting fixtures the manufacturers of equipment have available very comprehensive publications showing in detail sizes, shapes, and designs of all their products. These will be found of great value in making distinctive designs and no difficulty should be experienced in producing fixtures to conform with any architectural treatment which is considered advisable. The steps to be taken in planning a lighting installation then are as follows: (1) Determination in a general sense the type of the lighting to be used including decoration and kind of unit; (2) Spacing of outlets from architectural considerations; (3) Intensity required; (4) Calculation of capacity of outlets from Tables 2 and 4; (5) Necessary wiring in-



FIGS. 3 AND 4. DISTRIBUTION CURVES FOR DIRECT AND SEMI-INDIRECT LIGHTING UNITS.

stallation; (6) Final selection of fixtures with reference to mounting height, selection of accessories (glassware, etc.) and general design to conform with architectural treatment of buildings.

It is to be remembered that the plan of procedure indicated in this paper is not given as hard and fast rules but rather as a suggestive method to be used as a basis of design. Also that the mere fact of obtaining a certain intensity value on the working plane does not constitute all the necessary considerations in planning. One system may be suitable for some certain class of service which would be very much out of place in another. The scope of this paper does not permit any general rules which cover all cases. It is hoped that each individual case be given special study and that a general betterment of conditions of artificial illumination will result.

TABLE 1—DATA ON LAMP VALUES.

Kinds of Filament.	Horizontal or Nominal C. P.	Watts.	Light Units (Lumens).	Multiplying Factor.
Carbon	2	10	21	4.59
Carbon	4	20	50	3.84
Carbon	8	30	95	3.02
Candelabra Carbon	8	31.1	96	3.10
Gem	20	50	207	2.31
Gem	32	80	337	2.28
Tungsten	7.7	10	76	1.26
(Mazda)	12.0	15	118	1.22
"	17.1	20	168	1.14
"	21.9	25	215	1.12
"	36.4	40	357	1.08
"	56.0	60	549	1.05
"	98.0	100	960	1.00
"	167.0	150	1637	.882
"	278.0	250	2722	.882
"	445.0	400	4535	.847
"	556.0	500	5665	.847

TABLE 2—FOOT CANDLE INTENSITIES RECOMMENDED FOR VARIOUS CLASSES OF SERVICE.

Armory	2.0—
Art Gallery (Walls)	5.0—10.0
Auditorium	1.0— 3.0
Automobile Showroom	3.0— 6.0
Bank (General)	2.0— 3.0
Bank (Desks)	4.0— 6.0
Billiard Room (General)	.8— 1.5
Billiard Table	6.0 —10.0
Cafe (General only)	2.0— 4.0
Cafe (with Table Lights)	1.0— 2.0
Card Room (Tables)	2.0— 3.0
Church	1.0— 2.5
Drafting Room	6.0—12.0
Desk	4.0— 6.0
Engraving	10.0—12.0
Factory (General only)	.8— 1.5
Local Bench (Fine Work)	5.0—10.0
Local Bench (Coarse Work)	3.0— 5.0
Gymnasium	1.0— 3.0
HOTEL.	
Bedroom	1.5— 2.0
Corridor	.6—
Dining Room (General)	2. — 4.0
Dining Room (Lights on Tables)	1.0— 2.0
Lobby	2.0— 4.0
LIBRARY.	
Stock Room	1.6— 2.0
Reading Room (General)	3.0— 4.0
Reading Room (With Local)	.7— 1.5
OFFICES.	
Small Office (Private)	3.0— 4.0
Small Office (General)	3.0— 6.0
Large Office (General Illumination)	3.5— 5.0
Large Office (With Desk Lights)	1.5— 2.0
RESIDENCES.	
Hall	.7— 1.0
Parlor	1.0— 3.0
Living Room	1.5— 2.5
Library	1.5— 2.5
Dining Room	1.0— 3.0
Kitchen	2.0— 3.0
Laundry	1.5— 2.0
Bedroom	1.0— 3.0
Bathroom	2.0— 3.0
Store and Furnace Rooms	.4— .8
STORES.	
Clothing	4.0— 7.0
Dry Goods	4.0— 7.0
Furniture	2.0— 4.0
Grocery	2.0— 4.0
Hardware	2.0— 4.0
Jewelry	4.0— 6.0
Millinery	4.0— 6.0
Shoes	2.0— 4.0
Stationery	2.0— 4.0
Warehouse	.5— 1.0

TABLE 3—DESIRABLE SIZES OF SQUARES.

Kind of Room.	Ceiling Height.	Desirable Length of Side of Square.
Armories	12—16	12—16
Auditoriums	12—16	12—16
Public Halls	over—16	15—26
Rinks	over—16	15—26
Stores	8—11	8—11
Stores	11—15	10—16
Stores	over—15	14—22
Offices with desk lamps	10—20	12—18
Offices without desk lamps	9—12	7—11
Offices without desk lamps	12—16	9—14
Offices without desk lamps	over—16	11—18

Growth of Electrical Vehicle Interests.

The development which the year 1913-14 has witnessed in the electric vehicle field is shown by the progress of the Electric Vehicle Association of America. Starting off last year in October this association had but 437 members, with but two cities in which local organizations had been organized. Since that time the membership has been increased to approximately 850—about 100 per cent—and the sectional representation has expanded until it now includes New England, Chicago, Philadelphia, Washington, Cincinnati, San Francisco, Los Angeles, Pittsburgh, New York, Detroit, Cleveland and Toronto with expectations of having local sections in the immediate future in Buffalo, St. Louis and three or four other cities. In each of these local sections organized efforts are being put forth to promote the sale and use of electric vehicles, both passenger and commercial and it is safe to predict that these mediums will greatly facilitate vehicle development work in the future.

The fifth annual convention of the association is to be held in Philadelphia, October 19 to 21, and already the details of an interesting program are well under way.

Don't knock the man above you. Don't try to pull him down. If you want his job, boost him into the next higher job and the chances are that he will take you up with him. If you try to knock him down he will know it and knock you down first. He has the advantage. This is good sense as well as good gospel.

TABLE 4—WATTS PER SQUARE FOOT TO PRODUCE ONE FOOT CANDLE ILLUMINATION. (Watts per Lumen.)

	Ceiling—Light.			Ceiling—Medium.			Ceiling—Dark.	
	Walls			Walls			Walls	
Type of Lighting Equipment.	Light.	Medium.	Dark.	Light.	Medium.	Dark.	Medium.	Dark.
Mirror (Bowl Type Direct)	.180	.186	.196	.183	.193	.196	.196	.196
Prismatic (Clear)	.180	.204	.208	.225	.240	.263	.263	.270
Prismatic (Satin Finish)	.230	.251	.277	.257	.277	.309	.309	.337
Prismatic (Velvet Finish)	.200	.220	.240	.220	.240	.251	.277	.284
Opal Enclosing Unit	.300	.327	.360	.384	.372	.416	.491	.540
Prismatic Enclosing Unit	.216	.230	.245	.240	.251	.284	.300	.309
Opal Reflector (Heavy Density)	.200	.208	.225	.216	.225	.235	.235	.235
Opal Reflector (Medium Density)	.216	.235	.251	.240	.251	.284	.292	.300
Opal Reflector (Light Density)	.229	.251	.277	.263	.277	.308	.318	.327
Enameled Steel (Dome Shaped)	.204	.216	.225	.208	.220	.225	.225	.225
Enameled Steel (Bowl Shaped)	.225	.235	.245	.229	.240	.245	.245	.245
Semi-Indirect	.251	.284	.318	.386	.415	.470	Not recommended	
Indirect (Mirror Reflector)	.349	.386	.415	.514	.568	.633	Not recommended	
Bare Lamp	.270	.309	.372	.309	.372	.432	.450	.514

COLOR CLASSIFICATIONS.

Light	Medium	Dark
White	Yellow	Green
Cream	Light Buff	Red
Light Gray	Light Blue	Brown

Some Tendencies in the Design of Illuminating Glassware.

BY E. B. ROWE, CHIEF ILLUMINATING ENGINEER, HOLOPHANE WORKS OF G. E. CO.

IT is frequently and logically asked on what conditions the trend of development in lighting glassware at any time depends. In the writer's opinion there are three primary influences that govern such developments. First, origination by designers, and stimulation of "fashions" in other materials and articles, and their mode of use; second, progress in the art and science of illumination; third, lamp developments. Any attempt to give an order of importance to these influences would be futile indeed, for in some cases glassware is developed for one reason and in other instances for some entirely different reason. As for the "origination of designers," this might more truthfully be called "adaptation" since, as in most other fields of manufacture, the designer is obliged to utilize the period motifs and essential features of contemporary or earlier use of material.

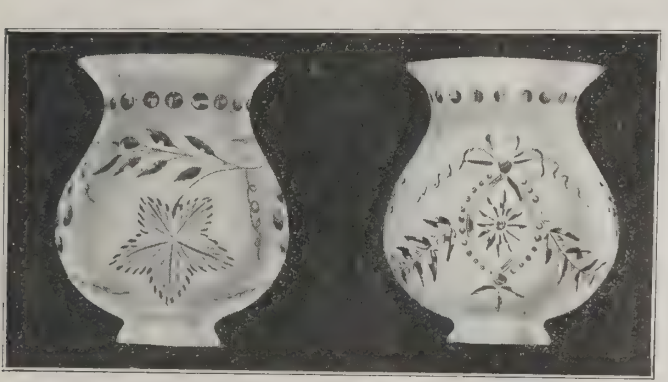


Fig. 1. Colonial Types of Crystal Cut Shades.

Obviously the "right time" is when they strike the popular fancy, or are "in fashion." For instance, just now the colonial effects are popular, involving Adam and Heppel white designs; *cretonne,* colored flower and leaf effects; candles, etc. This calls for shields and shades for candle brackets and candlesticks; color treatment and correct shapes for upright and pendant shades, tables lamps, and semi-indirect bowls; Adam designs for etched and color ornamentation, etc. In short, to sell readily, certain kinds of glassware must be "in style." Fig. 1, illustrates true colonial designs in crystal cut shades while Fig. 2, shows two dresser lights in a bedroom of the writer's residence, the etched shades for which carry out the colonial effect of the wall paper and furnishings by means of a rose-colored pattern—this, unfortunately not being visible in the illustration. Similarly, in the colonial dining-room, Fig. 3, the semi-indirect fixture has been adapted by the addition of electric candles.

A striking illustration of changing "styles" in lighting methods and glassware can be found in so-called "white-way" incandescent street-lighting systems. This situation can be likened to the evolution which took place several years ago in interior lighting, resulting in the almost complete disappearance of the old-style "chandelier" with its numerous low candle power carbon lamps and useless shades, and the substitution of single-light or single-piece units with larger lamps. The old string-of-lights and arch methods of street lighting first gave way to the post system with from three to six or more lamps each. This type of design seemed rather popular, resulting in numerous installations, many of which have been found to be decidedly uneconomical and expensive to install and maintain. The next step was the logical replacement of the "cluster" by a single lamp, and this resulted almost simultaneously in the development of a glass enclosing unit to give a light distribution better suited to street-lighting demands than the circular distribution from opal balls, or the slightly modified bare lamp distribution obtained with roughed balls. In Fig. 4, A and B, the day and night appearance of a new Holophane unit mounted on standards of special design, is shown, while Fig. 5, gives the distribution obtained with a 1000 watt type "C" tungsten or high efficiency lamp.

Like "Frenchy" furniture and full skirts, it is believed that cluster street-lighting has "gone by" as is evidenced by the wide and increasing popularity of this unit with high candle power lamps. Not only will the new installations consist of single-light units, but where such changes are made possible by the easy removal of the cluster top on present standards, the post manufacturers will be called upon to modernize many present installations of cluster posts by substituting the single-light unit.

The influence of progress in illumination principles and methods, and our present knowledge of what constitutes good illumination, on glassware for certain kinds of service, is certain to be considerable. Thus one very potent—if indirect—influence is the work of the Illuminating Engineering Society, whose officers and members fully realize

Fig. 2. Dresser Lights Having Crystal Etched Shades With Design in Color.

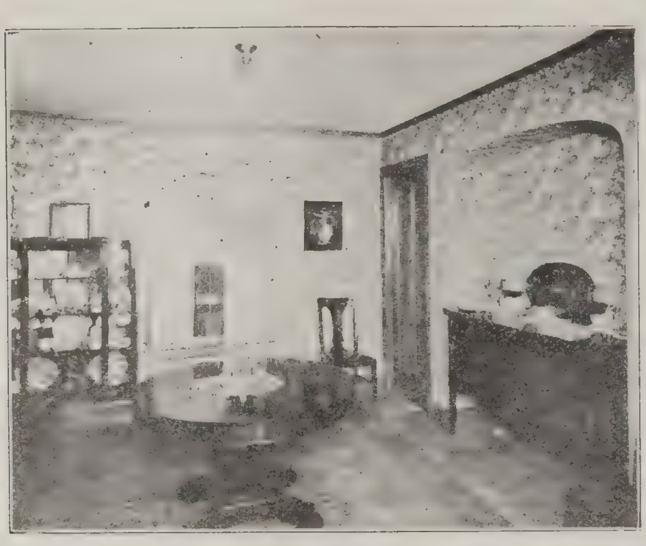


Fig. 3. Adaptation of Indirect Bowl to Semi-Colonial Dining Room by the Addition of Electric Candles.

the lasting benefits they can stimulate in the lighting field, and whose various committees are working faithfully to educate the general public in lighting matters.

As an example of the influence of greater knowledge in illumination principles on glassware design, contrast the glaring inefficient globes and shades of six or eight years ago with the variety of pleasing, comfortable and efficient reflectors, globes and indirect units now available. Recall the development of glassware giving standard light distribution (extensive, intensive, focusing and concentrating) and the immense educational power for good these were—and are—in displacing guess-work in illumination, and cheap, inefficient material. A greater knowledge of the evils of glare has resulted, first in greater depth of reflectors, then better diffusion by totally enclosing glassware, and finally in the development of the totally—and semi-indirect unit, and such modifications of filament-screening direct lighting units as the "concentric diffuser" with its recent imitators in glass, and glass-metal combinations. Not only is progress in the art and science of illumination reflected in glassware design, but to an even greater extent perhaps, in methods of use and application, ability to analyze glassware performance and in better test apparatus and methods.

As to the influence of lamp developments on glassware design, we have but to compare the low candle power, small bulb carbon, gem, and tantalum lamps of a few years ago with the almost infinite variety of sizes and styles of Tungsten (Mazda) lamps now in use, to realize what an effect constant additions to and changes in types of these lamps have had on the manufacture of illuminating glassware. In the case of manufacturers whose product is chiefly designed to give predetermined light distributions with maximum output, these changes have necessitated continual study of the effect of variations in natural distribution from the lamp, of filament size and position, of size and shape of glassware, etc.

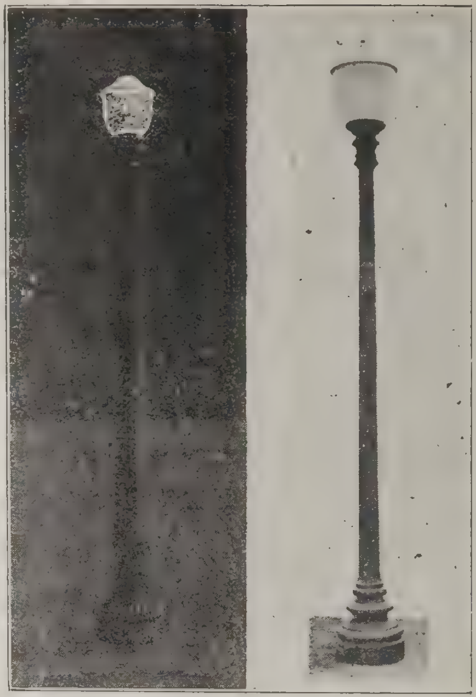


Fig. 4. Holophane Ornamental Street Lighting Unit; A—Day View of Unit on Post Specially Designed For it by The Geo. Cutter Co.; B—Night View on Post of the Union Metal Mfg. Co.

As lamps of higher and higher wattage have been produced, new factors have been introduced into glassware design, such as adequate ventilation and requisite mechanical strength. Fig. 6, is an illustration of the new 16-inch design known as the Holophane-Realite, for use with 750 and 1000 watt lamps, having provision for increased ventilation by entrance of air at the lower band and exit at the holder, and steel straps from holder to lower band to insure the requisite factor of safety mechanically. With the recent advent of the high efficiency (Type C or gas-filled Tungsten lamp) came new problems in diffusion and new possibilities in distribution—especially with Holophane prismatic combinations—due to the tremendous brilliancy and high concentration of the helically coiled filament in these lamps. From the diffusion standpoint, Fig. 7, is interesting, as it illustrates a new direct-lighting unit giving excellent diffusion, but which would ordinarily be classed as an indirect unit by those not familiar with the finer points of illumination performance. By substituting a heavier density opal in the bottom piece for the light density Veluria glass which is standard, and replacing the Veluria top plate by one of crystal roughed glass, this unit would become a true indirect unit with a small component of direct light. The tremendous variation in performance and light distribution which can be effected by a simple substitution of glasses in this way, is hardly realized by the layman, since these two variations of the same unit

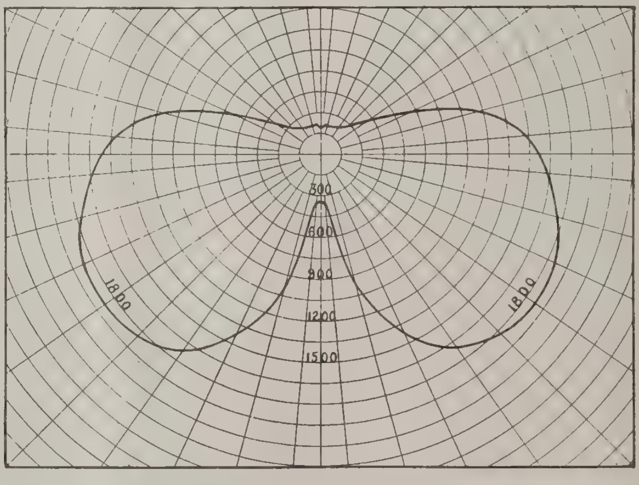


Fig. 5. Distribution from Ornamental Street Lithting Unit, With 1000 Watt Lamp.

would appear very much the same to the untrained eye.

The possibilities of efficiently redirecting the light from incandescent lamps have not been fully realized until recently, owing to limitations imposed by the material size of filament mounting. With the entire filament confined in a very small space, as it is in the lamp construction of Fig. 8, the light source approximates the theoretical "point-source" and better control by specular reflection and refraction is secured. While good concentration in a beam or narrow cone of light has been readily obtainable, concentration near the horizontal through a complete circle of 360 degrees, has hitherto been unobtainable in commercially practicable glassware. For example, in one field of lighting—the streets—although the best material available has been utilized, results have consequently fallen far short of the ideal.

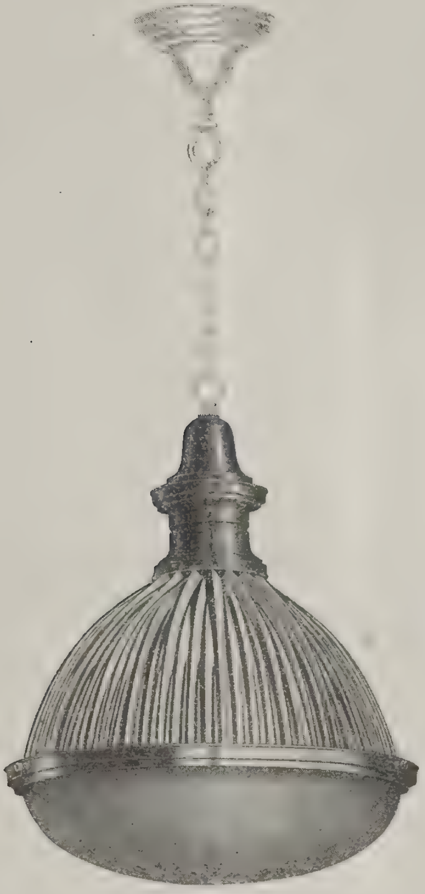


Fig. 6. Holophane-Realite Design With Specially Designed Fixture to Give Adequate Ventilation With 750 and 1000 Watt Lamps.

In taking advantage of the greater facility for light control made possible by the lamp construction mentioned, to obtain concentration near the horizontal, the manufacturer of prismatic glassware reverted to a patented prism formation which had years before served its purpose well, but which had seemingly outlived its usefulness. This was the well known combination of vertical diffusing flutes and horizontal redirecting prisms. A unique improvement was effected, in that the flutes and prisms were on two entirely separate parts, which in the finished article are hermetically sealed together at the top and bottom, with the flutes and prisms in juxtaposition in the air space between the parts. This leaves the actual completed globe smooth on both inside and outside, thus removing entirely the objection—popularly much overestimated—of dirt collection on the prisms of prismatic ware.

The construction of the "Holophane double internal refractor" as it is called, is shown in cross section in Fig. 9, and the appearance of a complete refractor street lighting unit in Fig. 10. The remarkable redirection of light into the zone most effective in street lighting, or wherever units are widely separated, is evident from the comparison (Fig. 11), of the distribution from the unit shown in Fig. 10, and that for the high efficiency series Tungsten lamp alone. Not only can a uniform circular distribution be secured by the refractor, but by the substitution of properly designed vertical redirecting prisms in place of the diffusing flutes, concentration can be obtained longitudinally as well as latitudinally. While such a unit has not been placed on the market as yet, the photometric results obtainable are shown in Fig. 12, one curve being the distribution up and down the street for example, the other across the street.

We come now to a consideration of the factors which the designer must equate in developing any new ware: First, price; second, appearance; third, performance; fourth, mechanical strength; and, fifth, adaptability to standard fixtures. Obviously price must be justified by the other factors, either singly or in combination, the factor of most importance depending primarily on the nature of the installation. For example, in a magnificent church or similar auditorium, appearance may be the only consideration (reasonably good performance being assured), while in another installation mechanical strength and safety may outweigh everything else, and in still another, the best possible performance is to be sought.

Judgment of glassware as regards appearance usually depends on personal preference and prejudice, involving such characteristics as, shape or contour, color, ornamentation, and diffusion. Shape may appeal principally because of the fixture on which the glassware is used. Color may

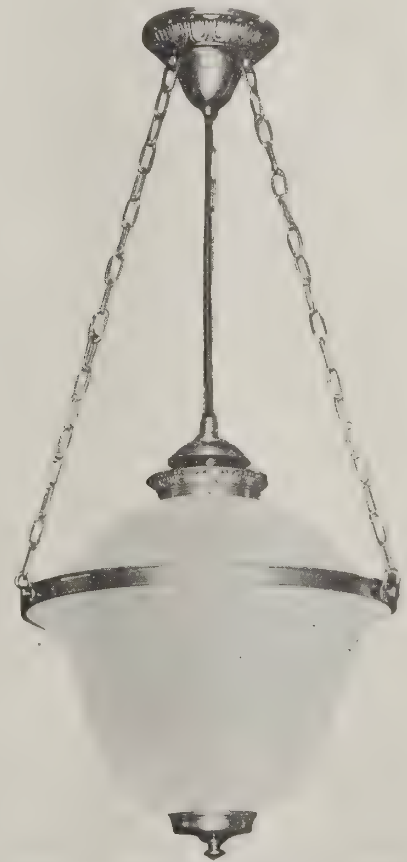


Fig. 7. Veluria Diffusing Unit—A Direct Lighting Unit With Relatively High Indirect Component.

be carried in the glass itself and be equally effective cold and lighted, it may be applied as a toning, effective by reflected natural light and not at all by transmitted artificial light, or as a casing invisible in daylight and active by transmission under artificial light. Ornamentation may be effected by cutting, as in real "cut glass" (Fig. 1), by etching, with the pattern either raised or depressed, as in Fig. 13-A, or by molding, as in the pressed semi-indirect bowls shown in Fig. 13-A. Diffusion may be obtained by refraction, in clear crystal glass as in pendant prism-glass bead combinations and Holophane prismatic ware, by irregular reflection and refraction in roughed and etched ware, or by multiple reflection, as in opals. The glitter and sparkle of clear crystal glass appeals to some of us, while others prefer the diffusion of roughed glass or a combination of the two. Some individuals like an opal so light in density that it hardly obscures the lamp filament, while others demand maximum diffusion and uniform surface brightness.

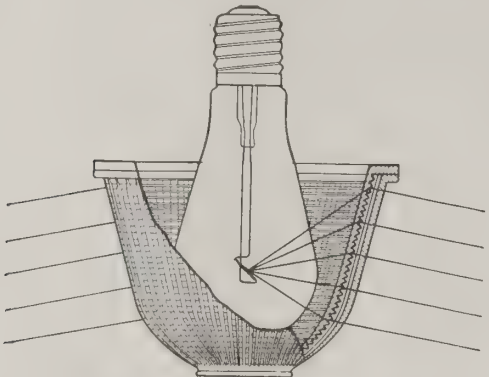


Fig. 9. Illustrating Construction and Light Control of the Holophane Double Internal Reflector.

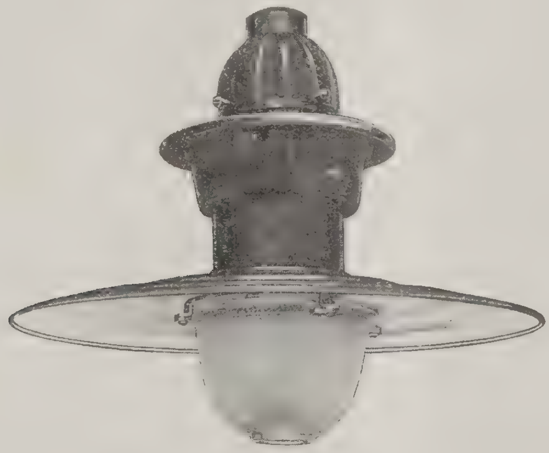


Fig. 10. Complete Holophane Refractor Unit for Series Sreet Lighting.

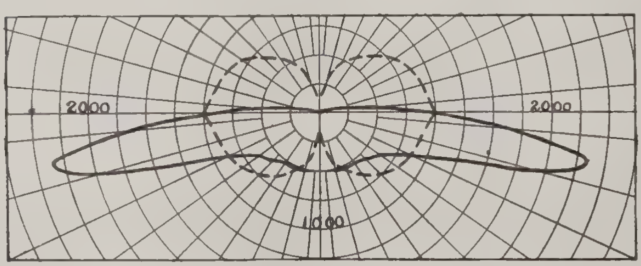


Fig. 11. Distribution from Holophane Refractor Unit With 1000 Candle Power, 20 Ampere Series Tungsten Lamp—Maximum Candle Power at 80 Degrees for Effective Street Lighting.

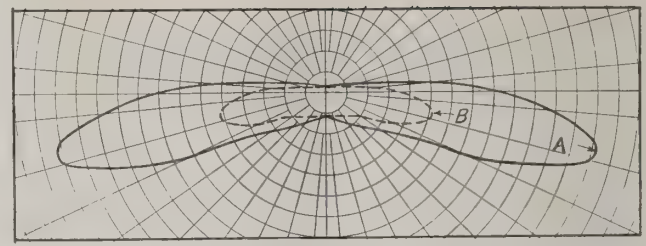


Fig. 12. A Symmetrical Refractor Distribution; A—in Plane Up and Down Street; B—Across Street.

The same thing cannot be said of performance, however, for here the "personal equation" plays no part—everything is on a definite, measurable, physical basis. As applied to illuminating glassware, performance may be said to include distribution, output, color, diffusion and depreciation. As was stated above in connection with price, distribution must be justified by the other factors, or justify them. For instance, if powerful concentration is required, a relatively low output and absolutely no diffusion are to be expected. The reverse is rarely true, however, namely, that a high output is ample justification for a decidedly ineffecient distribution. For example, a certain reflector may have 10 per cent more total *output* than another, but 25 per cent less flux in *useful angles*, or again a reflector having 10 per cent more output in useful angles, is decidedly inferior, in the writer's opinion, to the one having the lower output but a 10 degree lower cutoff of direct light, when the better

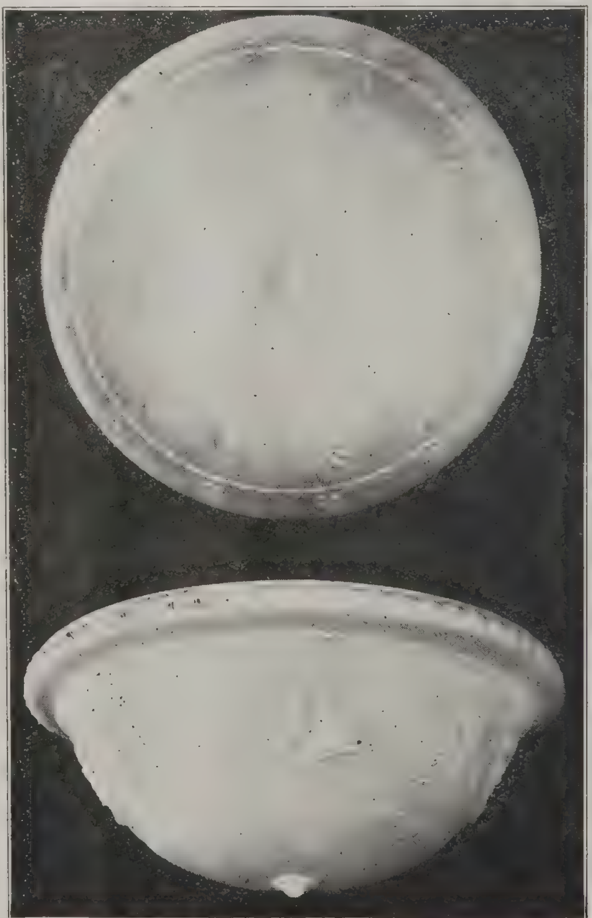


Fig. 13-B. Druid Semi-Indirect Bowls from Special Design by the U. S. Treasury Dept. These Illustrate Ornamentation by a Molded Design.

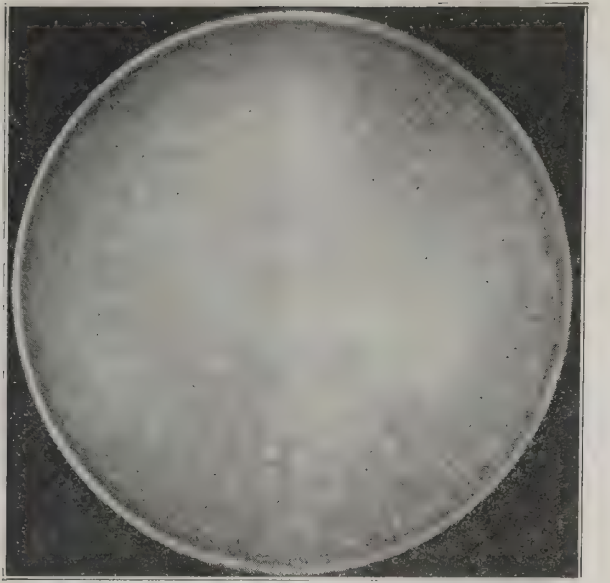


FIG. 13-A. SEMI-INDIRECT BOWL HAVING A RAISED ETCHED DESIGN WITH BACKGROUND IN COLOR.

screening results are in vastly better working conditions. In the same way, with high brilliancy light sources, output may be sacrificed for the sake of perfect diffusion and comfortable appearance, provided good illuminating efficiency is secured through good distribution.

On the physical basis that we are now considering performance, color is entirely divorced from any question of personal preference—it is purely a matter of spectral composition as measured by laboratory instruments. The carbon lamp gives a light high in the orange and red, the carbon arcs high in purple, the mercury vapor lamp high in the green, with the magnetite arcs close to daylight. The introduction of the Tungsten lamp at 1.25 watts per candle gave a decidedly whiter light than that from the carbon, the 1.00 w. p. c. lamp still whiter, and the so-called "half-watt" lamp, while considerably whiter yet, is still appreciably different from average daylight or even sunlight. As certain processes and materials require correct daylight color value, it was only natural that for such special service the Tungsten light should be properly modified by accessories, and the color—correction can be accomplished of course only at the expense of total output. So that here again output, and in some cases diffusion, must be sacrificed to obtain a desired color quality.

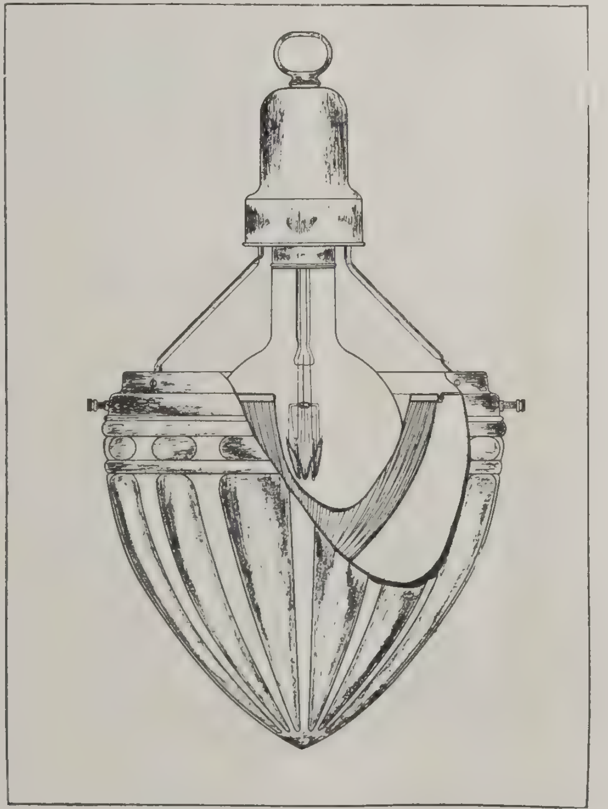


FIG. 15. HOLOPHANE PRISMATIC REFLECTOR—OPAL GLOBE, SEMI-INDIRECT UNIT FOR HIGH CANDLE POWER LAMPS.

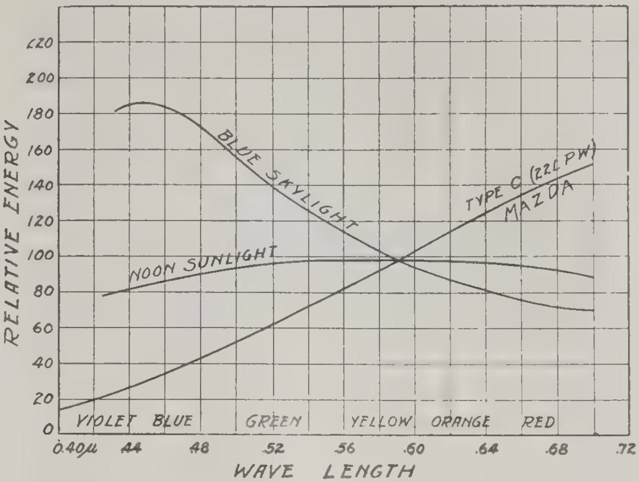


FIG. 14. CURVE SHOWING THE COLOR COMPOSITION OF TUNGSTEN LIGHT COMPARED WITH SUNLIGHT AND SKYLIGHT. FROM AN ARTICLE BY M. LUCKIESH, ELECTRICAL WORLD, JULY 18, 1914.

The diagram in Fig. 14 shows graphically the relative proportions of light of different wave-length or color in light from a blue sky, from the sun when directly overhead at noon, and from a Tungsten type "C" lamp giving 22 lumens per watt. It indicates the amount of correction in light from the type "C" Tungsten lamps, necessary to obtain respectively, noon sunlight and blue skylight. The development of glass to give this correction has resulted in a "Treutint" line, now being placed on the market, giving "sunlight" color at an efficiency of about 10 lumens per watt and "average daylight" at 5 or 6 lumens per watt with type "C" Tungsten lamps. As these lamps are available for 110 volt circuits, in wattages from 200 to 1000 inclusive, a tremendous field is thus opened up in industrial operations, stores, etc., for these true-color units.

Much might be said about *Diffusion* from the performance standpoint, but as stated above in discussing this under *Appearance*, any such statement would rest on

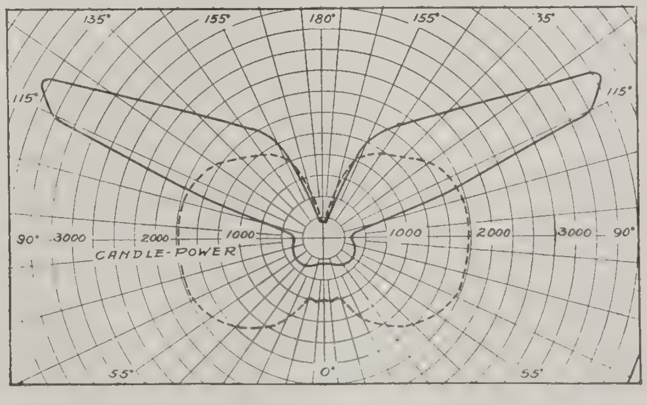


FIG. 16. DISTRIBUTION FROM SEMI-INDIRECT UNIT SHOWN IN FIG. 15, AND CURVE OF 1000 WATT TUNGSTEN ALONE.

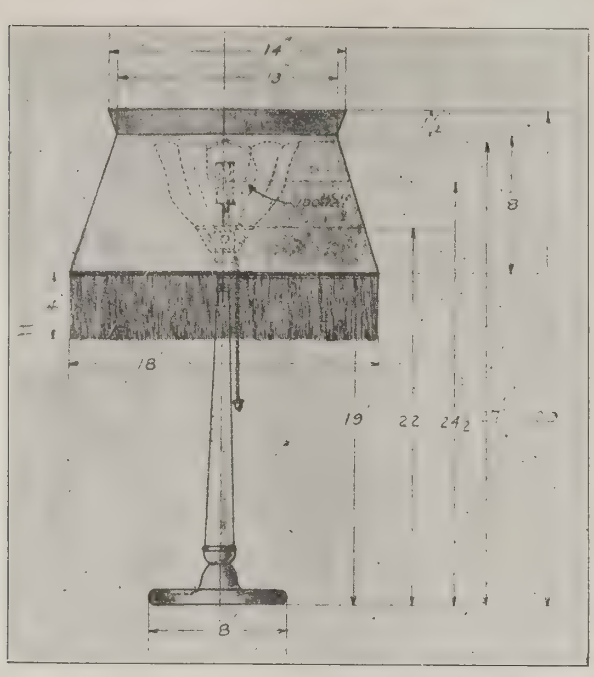


FIG. 17. DETAILS AND DIMENSIONS OF SEMI-INDIRECT TABLE LAMP EMPLOYING PRISMATIC REFLECTOR.

a personal rather than on a physical basis, since this characteristic of a lighting unit, or a lighting system, is one of the matters which still requires a great deal of scientific investigation before it can be exactly defined and rated in absolute physical quantities. We know, however, that good diffusion is of much more importance with high candle power lamps than was the case with lower candle power, less brilliant sources, and we also know that diffusion is obtained in various ways, one of which is by reflection from large surfaces external to the light unit—the ceiling for example, hence the development of semi-indirect units for these new lamps. This is a field where the ever-useful prismatic reflector has remarkable possibilities. Its low degree of transmission (15 to 20 per cent), gives just the right brilliancy when used inside opal bowls of light density, or even of silk and similar enclosures. In addition to high reflecting efficiency, prismatic reflectors possess peculiar advantages for use with high candle power lamps in this form of unit, being the strongest glass mechanically, and entirely unaffected by the relatively greater heat from these lamps. Fig. 15, shows the nature of one standard semi-indirect unit now on the market and Fig. 16 its distribution curve. The very wide indirect distribution obtained naturally results in uniform ceiling brightness even with relatively close mounting, a condition resulting in excellent diffusion.

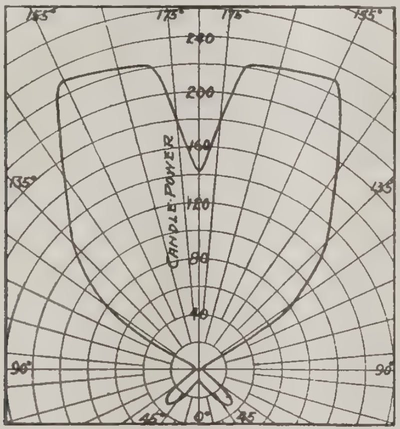


FIG. 18. DISTRIBUTION CURVE FOR TABLE LAMPS SHOWN IN FIG. 17.

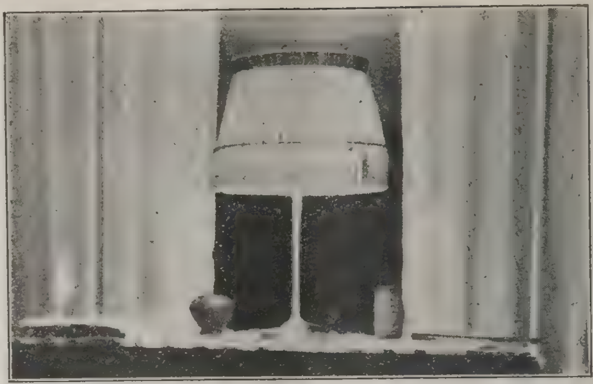


FIG. 17-A. TABLE LAMP SHOWN IN FIG. 17.

In the same way prismatic reflectors are being adapted to floor standards and table lamps so popular just now, with a large proportion of indirect light and a small but well distributed direct lighting component. Fig. 17 gives a sectional view of such a table lamp*, its distribution with a 100 watt clear lamp being shown in Fig. 18. The dark red silk shade, being lined with white silk, not only cuts down the light near the horizontal to a comfortably low intensity (two candle power), but also assists by reflection in producing the strong ray of direct light at just the right angle for comfortable reading. As a matter of fact, this lamp gives a uniform intensity of three foot-candles over a large library table. Since they are produced much less expensively than similar units of more complicated construction, combination of this sort can be made to give practically any desired distribution very economically, and with a little assistance from fixture manufacturers will

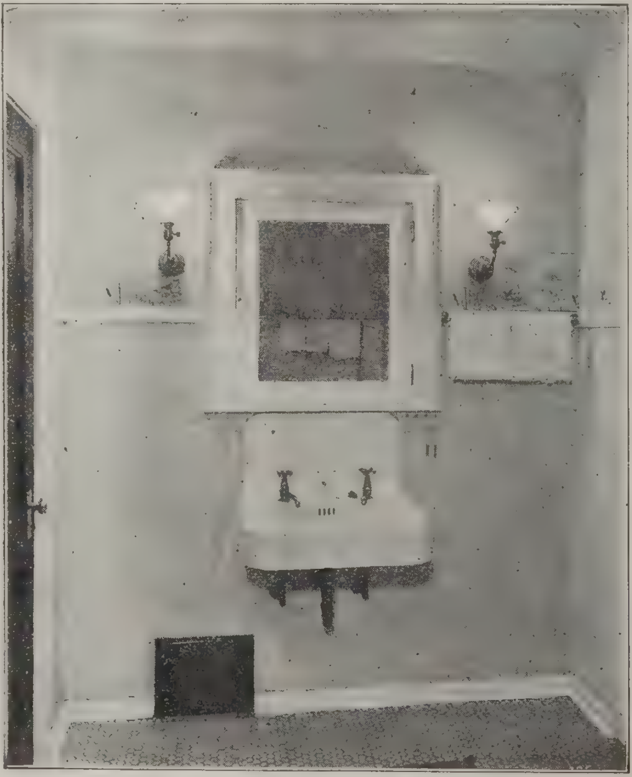


FIG. 19. LIGHTING FROM SIDE BRACKETS WITH CONSIDERABLE TRANSMITTED LIGHT AT THE PROPER ANGLE AND SECURING DIFFUSED ILLUMINATION.

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* Designed by Mr. E. J. Edwards, Associate Engineer of the National Lamp Works of General Electric Company.

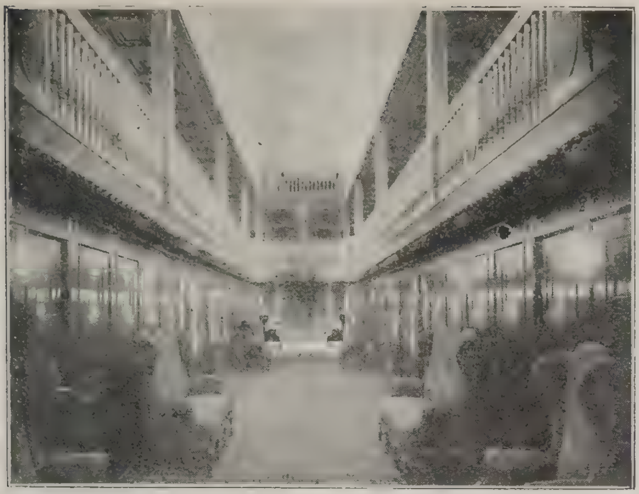

FIG. 20. LIGHTING OF THE S. S. NORONIC, NORTHERN NAVIGATION CO., LTD., J. MILTON DYER, ARCHITECT, A LIGHTING SYSTEM GIVING MAXIMUM DIFFUSION TO REVEAL DETAIL.

enable the "middle class" to have a degree of diffusion in their homes that is now enjoyed only by the well-to-do.

Diffusion can—and far too frequently is—obtained by reflection from walls as well as ceiling. Thus the "diffusion" obtained by using light density opal globes and reflectors is not only in the opal glass itself, but is due also to irregular reflection from upper side walls of uncontrolled light. Diffusion obtained in this way, often spells illumination inefficiency and in the writer's estimation the use of opal enclosing globes giving an approximately circular distribution is frequently unjustified, when equivalent diffusion and much better illumination results can be obtained by other means. This does not mean that a circular distribution and the reflection of considerable light from the walls is always to be avoided. For instance, the bathroom in the writer's residence is rectangular in shape with the lavatory placed at one end, medicine closet and mirror above it. Considering the illumination requirements to consist principally of adequate lighting of all parts of the face for shaving, two side brackets were provided on either side of mirror as shown in Fig. 19. Then in order to secure satisfactory intensities at the other end of the room. these were made upright units and equipped with a prismatic direct light at the required angle for lighting the face, but depending on the wall to reflect diffusely the light transmitted backward, and on the ceiling to reflect the indirect component thrown upward from the reflector. With such good conditions as here exist, wall reflection is highly efficient and a satisfactory means of obtaining the desired lighting effects.

In certain other cases, high transmission and circular distribution characteristics of good diffusing glasses, is absolutely required, not for reflection primarily but for wall and ceiling *illumination*. A detailed reference to Fig. 20 will make this evident. This illustration is taken from the first promenade deck through the second promenade deck to the smoking room on the boat deck of the new lake steamer Noronic, put into commission this season by the Northern Navigation Co., Ltd., (Grand Trunk Route) of Carnia, Ont. The writer considers this one of—if not the best lighted passenger steamer afloat. The architect, J. Milton Dyer, of Cleveland, was glad to accept expert illuminating engineering service and thereby based his illumination design on the very latest practice and materials.

Obviously the requirements here encountered were rather out-of-the-ordinary, inasmuch as revelation of the detail which is largely responsible for the surpassing beauty of the decorations constituted one of the main objects of the lighting system. Though much of this detail is lost in reproduction, still it is evident that the lighting design is effective in this respect and at the same time there is not the least glare from points of unduly high brilliancy. Concealed lighting was adopted throughout, not by indirect or filament-screening direct units, but by enclosing light and medium density opal glass in the form of oval, oblong and circular placques, shallow squat balls and bowls, and on the ceiling of the smoking room, as shown in the illustration, a deep stalactite globe. By keeping the size of each unit small, the candlepower low, and increasing the number of outlets, having them in the line of vision is not objectionable, as would otherwise be the case, especially since the smallest dimension of the glassware is presented to view. The fact that relatively low foot candle intensities are required considerably facilitites the design of an installation of this sort primarily for maximum diffusion and "spread." There is an increasing tendency in the design of interior lighting systems to entirely conceal the lamp by one means or another—a tendency entirely justified by the increasing efficiencies of Tungsten lamps—and this is resulting in a considerable and pleasing variety of glass units.

Little need be said as regards depreciation from the standpoint of performance, although this factor has been receiving more than passing thought of late in the design and development of new glassware. The object of course is to secure a minimum deposit of dust in a given time and greater ease of cleaning, but in certain types of units, for example, the indirect, serious and rapid depreciation is bound to occur, and regular, systematic cleaning maintenance should be enforced. The cost of energy is not yet so low that we can afford to turn part of our supply into the gutter, so to speak, and regular cleaning pays for itself many times over.

Summing up, the present tendency in the design of lighting glassware seems to be, first, an ever increasing variety of ornamentation by etching, color, molding and cutting; second, unimportant variations in the shape of bowls and globes, with few additions in reflector contours; third, new combinations of existing glassware to form so-called "diffusing" units, having somewhat higher efficiencies than most totally enclosing globes; fourth, an increasing number and use of wall placques; fifth, the development of units giving daylight color values—and here the unwary public may frequently be deceived by incorrectly prepared glasses or combinations which claim to give true daylight, but which do not correct the Tungsten light in the right proportions; sixth, the necessary introduction of larger units for the high candlepower types, involving new problems in diffusion, ventilation and mechanical strength, and new possibilities with prismatic ware and specular media in extreme distribution, due to filament concentration. It is the writer's earnest hope that the present apparent tendency to insufficiently reduce the extreme brilliancy of these large lamps just to "make a sale," by showing the highest intensities in competition, will arouse the active opposition of those thinking members of the lighting profession who have the real success of the "conservation" movement, and the consistent progress of the art and science of illumination, at heart.

Some Engineering Features of Office Building Lighting

BY E. J. EDWARDS AND WARD HARRISON, ILLUMINATING ENGINEERS.

WHILE the claims for most designs of reflecting units are generally known, there is little engineering data available for the different types when operated under the same set of conditions. In what follows the results of illumination tests are presented for various systems on the basis of equal quantity of light flax generated and in terms of the wattage required to give an average intensity of 5.0 foot-candles. The information and data are abstracted from a paper presented by the authors before the Illuminating Engineering Society, and refer to a group of new office buildings recently constructed just outside the city of Cleveland, Ohio.

The lamps used for the tests to be discussed were selected so as to give their rated candle-power when operated at the test voltage. The voltage for the test circuits was regulated by hand, thereby doing away with the necessity for voltage-candle-power corrections. In the tests which will be directly compared, the same lamps were used, except where one test required clear lamps and the other bowl-frosted. The bowl-frosted lamps were rated before being frosted and the "clear" values used in computations. Photometric readings were taken with a Weber portable photometer. The stations for all tests were as given in Figs. 1 to 4.

The various systems employed in the standard offices used for the tests were:

(A) Four direct, opal glass units, fitted with bowl-frosted tungsten-filament lamps.

(B) Same as A, except that reflectors are inverted and clear lamps used.

(C) One semi-indirect bowl with clear lamps in central outlet.

(D) One indirect plaster bowl with clear lamps in central outlet.

(E) Four mirrored glass indirect units with clear lamps.

(F) Four direct prismatic glass, intensive, with bowl-frosted lamps.

A single unit of each system is shown in Fig. 7. System A is the one generally adopted throughout the offices. The others are used in places where the requirements are special or where special consideration was given to the individual tastes of the occupant.

In the tests A-F lamps of equal luminous output were used, so that comparisons show the results obtainable with the different systems with the same amount of light generated at the lamps. It is hardly necessary to state that the same wattage is not to be recommended; however, it was thought best for purposes of comparison to make tests on this basis. Reflectors in all cases were of the correct size for the wattage of lamps used, except that in the mirrored glass reflectors it was necessary to use an extension in order to insure the proper lamp position. A summary of the results of tests A-F, as outlined above, is given in Tables 1 and 2.

TABLE 1—INTENSITY DISTRIBUTION.

Description	Test	Illumination foot-candles on 30-inch plane: Average	Maximum	Minimum	Efficiency: Lumens per watt	Per cent utilization efficiency
Direct, 4 units, opal glass, bowl-frosted lamps	A	4.58	5.54	3.89	2.95	32.5
Semi-indirect, 4 units, opal glass, clear lamps	B	2.69	3.01	2.32	1.73	19.0
Semi-indirect, 1 unit, diffusing bowl, clear lamps	C	3.19	5.63	1.75	2.05	22.6
Indirect, 1 unit, plaster bowl, clear lamps...	D	2.39	3.66	1.42	1.54	17.0
Indirect, 4 units, mirrored glass, clear lamps	E	2.65	3.04	2.20	1.70	18.7
Direct, 4 units, prismatic, bowl-frosted lamps	F	5.00	5.78	4.33	3.22	35.5

Room area—257.5 square feet and 4—100-watt lamps used in each test.

Ceiling height, 11 feet 10 inches. Height of unit above floor, Tests A, B and F, 10 feet 6 inches; Tests C and D, 9 feet 5 inches; Test E, 9 feet 9 inches.

Before comparing these systems with one another and with the efficiency figures in other installations, the exact conditions as regards spacing of outlets and character of walls and ceiling surface should be borne in mind. The walls are finished with a greenish-gray paint, which reflects 53 per cent as much tungsten-filament light as does white blotting paper. The white blotting paper used in all these

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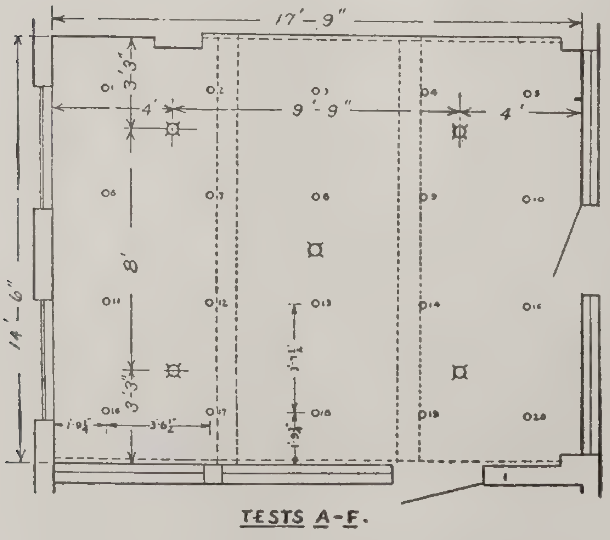


FIG. 1. STATIONS FOR TESTS A TO F.

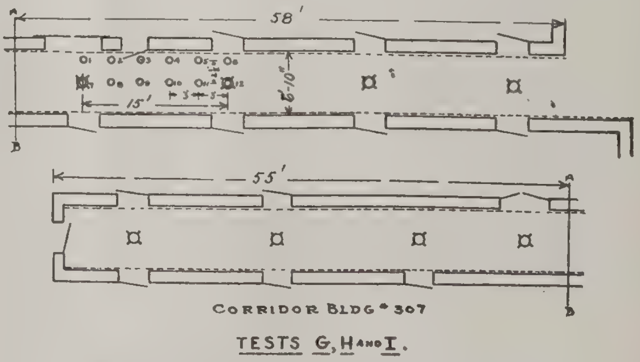


FIG. 2. STATIONS FOR TESTS G, H AND I.

tests showed, on measurement by the Nutting reflectometer method, a coefficient of reflection of 77 per cent. The walls, therefore, absorb 59 per cent. The ceilings reflect 76 per cent as compared with the blotting paper, and, therefore, absorb 41 per cent of the light falling upon them.

TABLE 2—SURFACE BRIGHTNESS DISTRIBUTION.

Description	Test	Surface brightness foot-candles equivalent to white blotting paper: Ceiling, Maximum	Ceiling, Minimum	Walls, Maximum	Walls, Minimum
Direct, 4 units, opal glass, bowl-frosted lamps ...	A	5.23a†	0.663b	6.03e	0.846f
Semi-indirect, 4 units, opal glass, clear lamps.	B	1.95a	0.561b	2.13e	0.477f
Semi-indirect, 1 unit, diffusing bowl, clear lamps	C	60.3a	0.768d	1.83e	0.593f
Indirect, 1 unit, plaster bowl, clear lamps....	D	65.1c	0.280d	1.32e	0.263f
Indirect, 4 units, mirrored glass, clear lamps	E	60.2a	1.040b	2.52e	0.461f
Direct, 4 units, prismatic, bowl-frosted lamps ...	F	3.59a	0.995b	2.67e	0.782f

It is possible with the best white paint to obtain a coefficient of reflection as high as 85 per cent. Measurements on new white finished plaster surfaces showed coefficient of reflection as high as 92 per cent. Therefore, with the very best possible conditions, as regards ceiling, the illumination of the indirect system could be raised more than 50 per cent. The semi-indirect systems could, of course, be made to show nearly as great an increase if the best possible ceiling surface were used. Table 3 is a summary of reflection data for all tests.

TABLE 3—SUMMARY OF REFLECTION DATA.

Surface	Reflection coefficient, per cent: Relative to white blotting paper as obtained by brightness readings	Absolute
White blotting paper	100	77
Walls in standard offices	53	41
Ceilings in standard offices	76	59
New factory white paint, worst	90	69
New factory white paint, best	110	85
New white finish plaster	120	92

At first thought it might be expected that some of the efficiencies would come higher, but considering the spacing of the outlets, shown in plan in Figs. 1-4, and bearing in mind the reflecting power of the walls and ceiling, one will see that in all the systems tested a large part of the light is necessarily lost by absorption of the walls. The lighting of rooms of a character similar to those tested involves not only the illumination of the working plane, but many other considerations, such as the lighting of the walls, the elimination of dense shadows on the desks, etc. Utilization efficiencies given apply strictly only to this one size room with the same character of walls and ceiling. They are not representative of what may be obtained with larger spaces, an example of which appears later in the paper. However, the size of the room and the finish of walls and ceiling represent a fair average of office buildings in general.

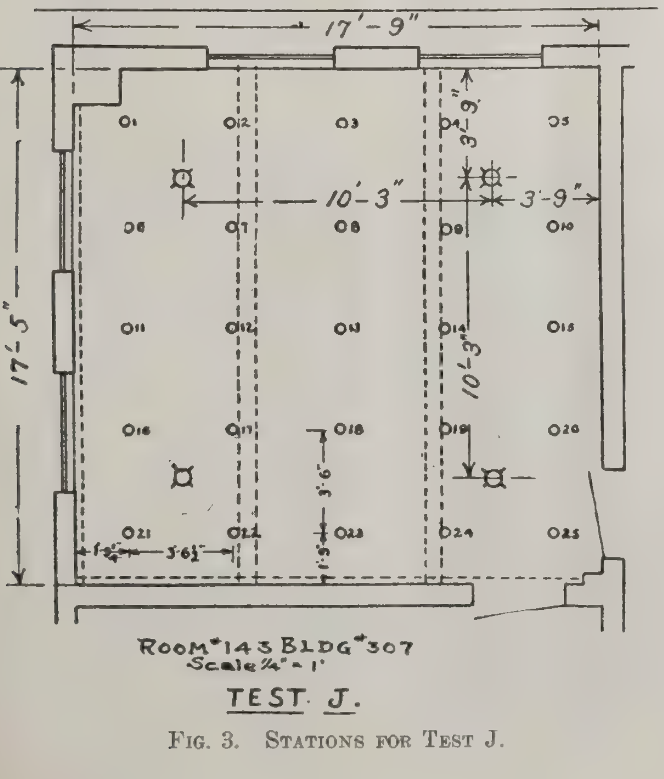


FIG. 3. STATIONS FOR TEST J.

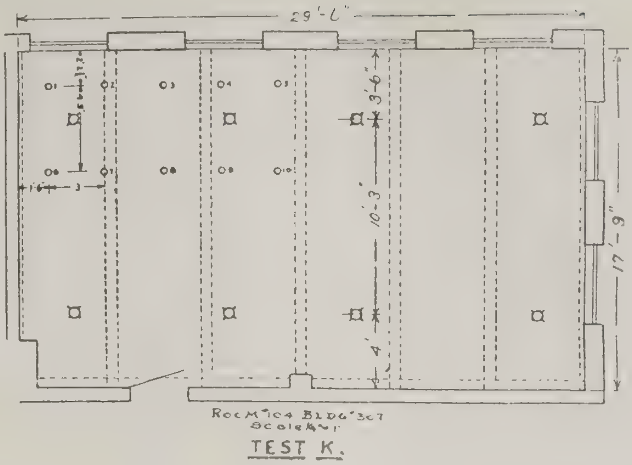


FIG. 4. STATIONS FOR TEST K.

From Table 1 it may be seen that the four 100-watt direct prismatic units gave an average illumination of 5 foot-candles, which is higher than for any of the others. Since the wattage in each test was the same, the prismatic units gave also a higher efficiency. Table 4 shows the wattage which would have to be used to obtain the same quantity of light on the 30-inch plane.

TABLE 4—WATTAGE TO SECURE SAME QUANTITY OF LIGHT.

Description	Test	Wattage necessary to produce an intensity of 5 foot-candles
Direct, 4 units, opal glass, bowl-frosted lamps.	A	109
Semi-indirect, 4 units, opal glass, clear lamps.	B	186
Semi-indirect, 1 unit, diffusing bowl, clear lamps	C	157
Indirect, 1 unit, plaster bowl, clear lamps...	D	209
Indirect, 4 units, mirrored glass, clear lamps.	E	189
Direct, 4 units, prismatic, bowl-frosted lamps.	F	100

The difference in the direct, semi-direct and indirect systems of lighting would, of course, be decreased if the ceiling were of a high coefficient of reflection. Even though the coefficient of reflection of the ceiling is only 59 per cent, it has been termed a good white ceiling by many observers, and so perhaps does not differ greatly from the average ceiling used in semi-indirect and indirect systems.

In comparing a central single unit system with the four-outlet system, one should bear in mind that the single unit throws less light on the walls, and, therefore, should give a higher average intensity on the 30-inch plane, everything else being equal. Some interesting comparisons of uniformity of illumination can be made. The ratios of maximum to minimum values are remarkably similar for all systems with the same arrangement of outlets. The brightness figures of Table 2 are of interest because they furnish some idea of the contrast presented to the eye. Fig. 8 is a key to the positions where the readings were taken. The brightest spot on the walls was one where the most specular reflection took place. Here again many interesting comparisons are possible. It is seen that all the semi-indirect and indirect methods show very high ceiling contrasts, but low wall contrasts. On the other hand, the direct units show low ceiling contrasts, but higher wall contrasts. This is, of course, as would be expected, but perhaps the actual magnitude of the differences will be of interest.

TABLE 5—INTENSITY DISTRIBUTION.

Description	Test	No. units	Area per unit sq. ft.	Wattage per unit	llumination foot-candles on 30-inch plane Average	Maximum	Minimum	Efficiency Lumens per watt	Per cent utilization efficiency
Direct, prismatic, totally enclosed, dirty, clear lamps, in corridor...	G	Single row	102.3	1/60	1.14	1.47	0.90	1.94	22.2
Direct, prismatic, totally enclosed, clean, clear lamps, in corridor...	H	Single row	102.3	1/60	1.27	1.63	1.02	2.17	24.7
Direct, prismatic, totally enclosed, clean, clear lamps, in corridor, alternate units turned on........	I	Single row	204.6	1/60	0.647	1.23	0.280	2.21	25.2
Semi-indirect, diffusing bowl, clear lamps	J	4	77.5	4/40	3.54	4.08	2.71	1.72	20.5
Direct, opal glass, bowl-frosted lamps	K	8	65.5	1/100	5.34	6.18	4.66	3.50	38.6
Direct, prismatic, clear lamps, wide spacing in basement	L	4	186.2	1/150	4.54	5.93	2.73	5.63	59.1
Direct, enameled steel bowl........	M	2 rows staggered	144.0	1/100	3.04	3.47	2.11	4.38	48.2

Ceiling height, Tests G, H, I. J. K, 11 feet 10 inches; Tests L and M, 12 feet 8 inches. Height of units above floor, Tests G, H and I, 10 feet 6 inches; Test J, 9 feet 5 inches; Test K, 10 feet 6 inches; Test L, 11 feet 5 inches; Test M, 11 feet 11 inches.

The results of other tests besides those in the typical office are given in Tables 5 and 6.

TABLE 6—SURFACE BRIGHTNESS DISTRIBUTION.

Description	Test	Surface brightness foot-candles equivalent to white blotting paper Ceiling Maximum	Minimum	Walls Maximum	Minimum
Direct, prismatic, totally enclosed, clean, clear lamps, in corridor....	H	3.22a	0.272b	1.69e	0.174f
Semi-indirect, diffusing bowl, clear lamps....	J	26.0a	2.27b	2.16e	0.583f
Direct, opal glass, bowl-frosted lamps	K	5.23a	0.663b	6.03e	0.846f
Direct, prismatic, clear lamps, wide spacing in basement	L	6.41a	1.18g	4.94e	2.12f
Direct, enameled steel bowl	M	0.454k	0.333k	1.79e	0.336m

Considering the first, Test J, the result of placing four of the semi-indirect bowls of Test C in a larger room is seen. The wattage per unit is cut down from 400 to 160, thereby reducing the brilliancy of the unit and ceiling. The utilization efficiency is not as good because of the wide spacing resulting in more wall illumination, but the uniformity is much better, the ratio of maximum and minimum illumination being 3.22 and 1.51 in the two cases.

A corridor is lighted by a single row of totally enclosed prismatic units containing 60-watt lamps. Readings were taken in a fairly typical section with all lamps lighted and the units in a somewhat dusty condition after eight weeks of use through a period when building construction was being completed. The lamps and glassware were then cleaned and tests made with all lamps and half of the lamps burning. The narrow hall cannot be lighted with the same efficiency obtained in larger areas, and in this case light thrown upon the walls was either largely absorbed by the dark finish or transmitted by the rough glass which forms a large portion of the wall area. It is, therefore, not surprising that the light on the usual reference plane does not exceed 25 per cent of that generated. The uniformity with all lights on is even better than would be considered necessary, as shown by a ratio of maximum to minimum illumination of 1.6. With half of the units in service, this ratio is 4.4.

The dust accumulation of eight weeks proved to reduce the illumination about 11 per cent at all points. This serves as another example of the necessity of cleaning lighting units. The eight-week period was probably equivalent to twice that for normal operation of the building.

The next series of tests are all on direct systems utilizing the three types of reflectors in very general use in office buildings—prismatic glass, opal glass and enameled steel.

The first test may be taken as indicative of what is to be obtained under favorable conditions with standard equipment of prismatic reflectors. The ceiling and upper part of the walls are finished in factory white, which, from tests, proved to have a high reflecting power. The value of 5.63 lumens-per-watt (uncorrected for photometer test plate error) with 150-watt lamps speaks for itself and is obtained at a utilization efficiency of 59 per cent. If increased 12 per cent for test plate error, the utilization efficiency be-

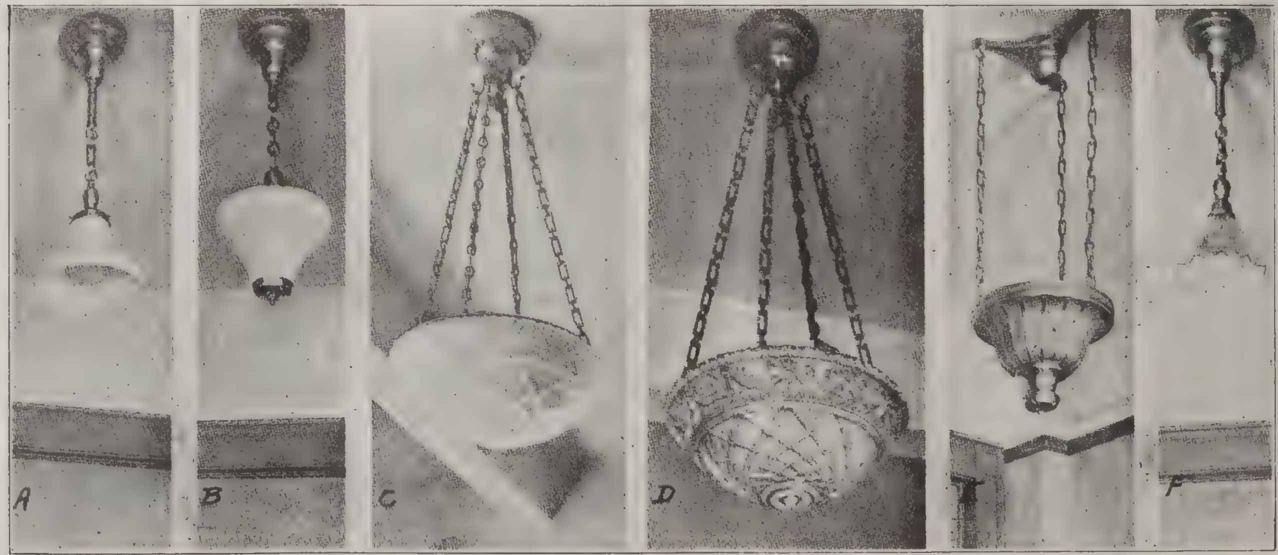
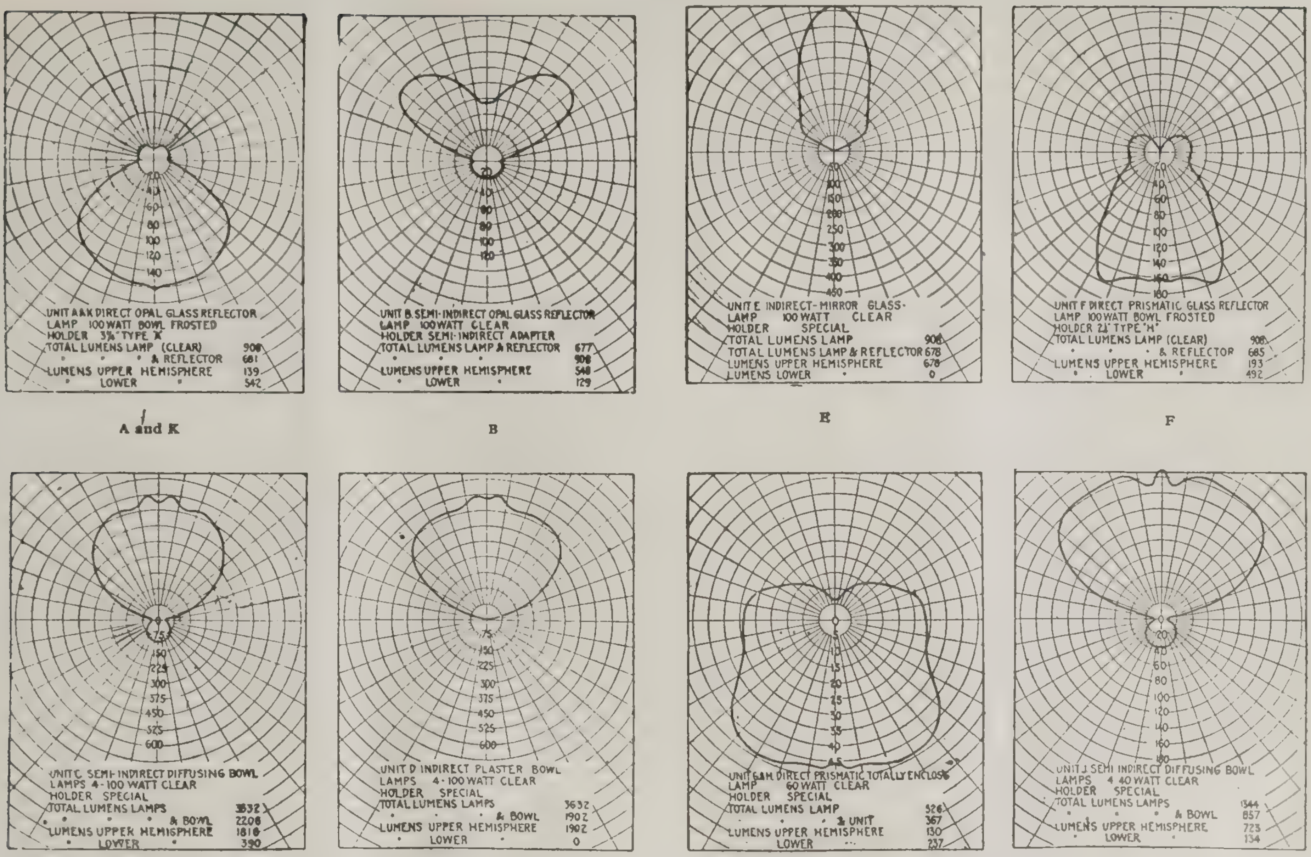


Fig. 7. Types of Units Used for Tests.



A and K B E F

C D G, H and I J

Figs. 5 and 6. Distribution Curves for Units Shown in Fig. 7.

comes 66 per cent. The spacing would be called fairly wide and the room large. It is seen that the uniformity is represented by the maximum-to-minimum ratio of 2.17.

Direct lighting opal glass units were installed in eight outlets in a room of the same width and characteristic finish as the offices, but having about twice the area. Compared with the prismatic installation just mentioned, the uniformity is better, but the efficiency not so good. By comparing with Test A, which is similar in every way except in size of room, something of the effect of wall absorption in small rooms may be seen. By doubling one dimension of the room, the utilization efficiency is increased from 32.5 to 38.6 per cent.

The test with 100-watt enameled steel units took place in the machine room, where objects are dark, but ceiling and walls light, as is fairly typical of certain service spaces in office buildings, and also in factories, where such lighting equipment is employed. The arrangement of outlets consists of two rows with units staggered. The uniformity index is good (1.64), and the utilization efficiency (48 per cent) is representative of what may be expected with this form of opaque reflector, under conditions where a small number of units contribute to the lighting of any one spot.

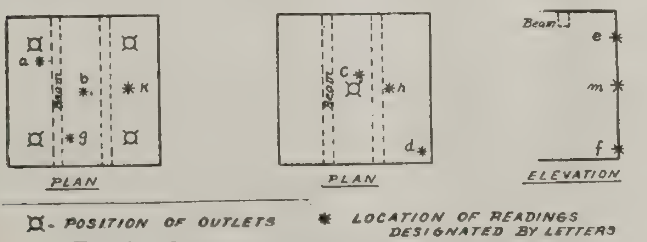


Fig. 8. Stations for Tests for Brightness.

The ceiling, since it receives all of its light indirectly, is very uniformly illuminated.

It was not the intention to attempt to draw any sweeping conclusions from these tests, but something should be said of the efficacy of the two methods of locating the outlets. The single office spaces usually have desks and cases placed next to walls. Many have tables in the middle. The central outlet system of lighting, either direct or indirect, is not considered entirely successful where the desks are placed next to the walls. In the conference rooms, where the work is done around a large table in the middle, either method is satisfactory. The four-outlet systems could have been designed for a higher utilization efficiency by placing the outlets nearer the middle of the rooms, but the best position of the fixture with respect to the natural desk position would have been sacrificed by placing the outlets nearer together.

New Business of Byllesby Properties.

All Byllesby properties reporting for the week of July 20-25, closed contracts for a total of 812 new lighting and power customers with an aggregate of 549 kilowatts lighting capacity and 746 horsepower in motors. The kilowatt hour output of the properties for the week increased 14.2 per cent over the corresponding period of 1913.

During the month of June, the Union Electric Light and Power Company of St. Louis, Mo., sold 1,059 fans as against 843 during June of 1913. A special auto-delivery service was inaugurated in order to deliver the fans to customers on the same day as ordered.

Important Recent Changes in Decorative Street Lighting.

BY ALAN BRIGHT, ILLUMINATING ENGINEER.

THE one factor that has had a great deal to do with the changes noticeable during the past few months in outdoor lighting, is the introduction of gas filled incandescent lamps. The perfection of the one-half watt lamp is certain to mean a more general extension of ornamental lighting, for if the cost of electrical energy remains the same, many small business centers can afford to maintain ornamental incandescent systems.

With the majority of the ornamental installations of lighting, the multiple system of distribution is employed with the lamps arranged in clusters of 3 or 5 lamps of 60 or 100 watts capacity. When the nitrogen filled lamp made its appearance those having charge of the maintenance of large systems immediately began to figure a method of using the more efficient lamp with a 5 light cluster arrangement. The spacing between posts usually varies from 65 to 120 feet, so that the simple substitution of 500 or 750 watt gas filled lamps for the 60 to 100 watt old type tungsten lamps was out of the question. The introduction of a single large post was therefore to be expected. The single light decorative unit has been used for some time in connection with the luminous arc lamp system for lighting business streets and it now looks as though downtown areas will also be lighted with single light posts supporting high power nitrogen lamps. It is to be expected, however, that on systems installed by merchants for spectacular and trade drawing effects, the 5 and 3 light clusters will continue to be used.

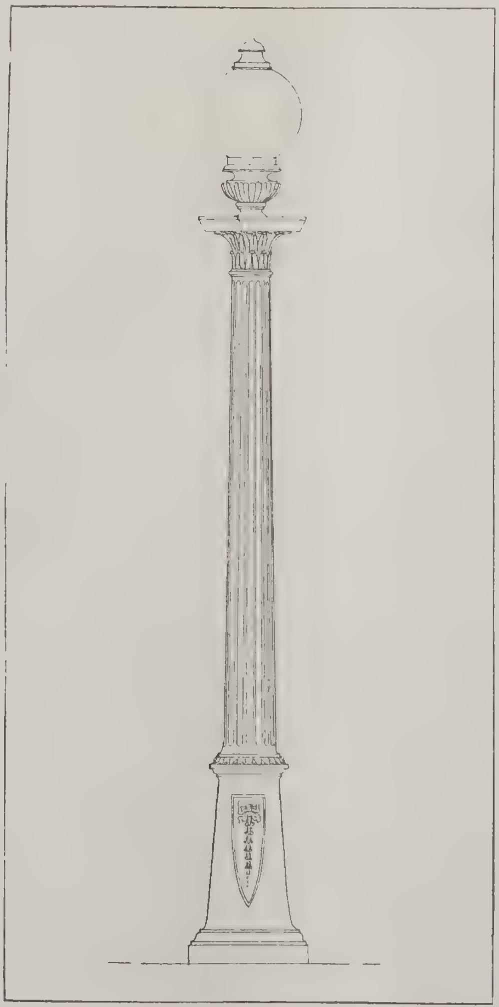


Fig. 1. Single Light Post With Globe and Ventilator.

It is often said that it is undoubtedly the case that our streets have too many posts. Where five light clusters have been placed on both sides of the street in addition to fire and police alarm pedestals, the thoroughfare usually has a crowded appearance and the general effect especially during the day is that the thing has been overdone. The introduction of single light posts supporting high candle power lamps enclosed in diffusing glassware, therefore, should tend to increase the post spacing and to remove the complications of the cluster system. Where cluster posts have been installed, it is not likely that single light posts will be substituted for this would be a burden on tax payers and merchants.

When the high power incandescent lamps are enclosed in ball globes the excessive heat developed makes it necessary to provide some means of ventilation. Perhaps the simplest method of accomplishing this is to provide a top fitter on the globe to which a spun copper ventilator may be attached. This part may be made of light material and equipped with thumb screws so that the globe may be easily removed by the cleaner. The holes providing for the escape of the heated air should be small enough to prevent insects from entering the globe. A pressed metal standard with 16-in. ball globe and ventilator is shown in Fig. 1. The design of the ventilator should be simple and should harmonize with that of the post to give a general ornamental effect. A rather simple design is shown in Fig. 2.

The size of the globe to be selected is often a question of considerable dispute. It is largely a matter of artistic judgment, yet the diameter of the post column and the height of the post have a great deal to do with the selection of the size of the globe. The more common sizes for single light posts are the 16-in. and 14-in., although the

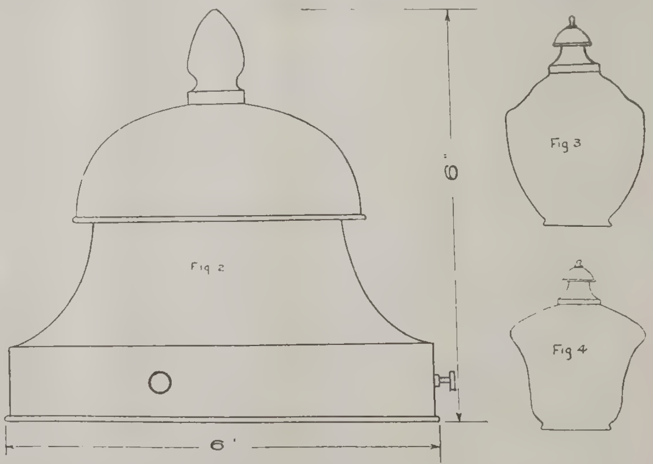


Fig. 2. Ventilator Used With Nitrogen Lamp. Fig. 3 and 4. New Designs of Globes.

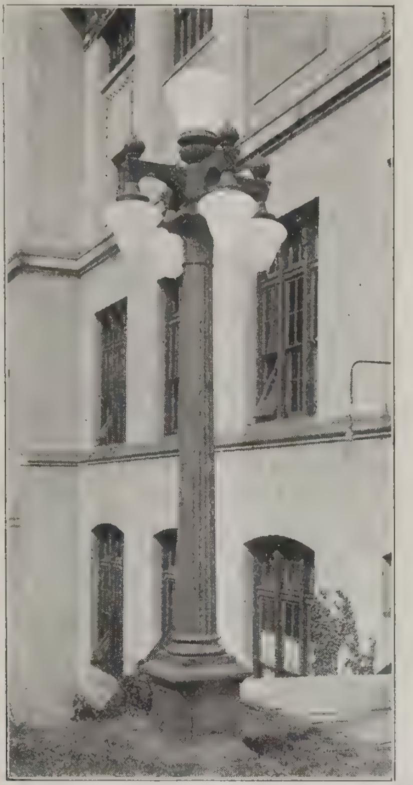


Fig. 5. Five Light Cluster With Newly Designed Globes.

18-in. is often specified. Sizes larger than 18-in. are seldom used on account of their cost.

INCREASED EFFICIENCY IN GLOBES.

Since the high efficiency incandescent lamps have come into use, attempts have been made to alter the design of the glass globes so as to secure a more economical distribution of the light. Figs. 3 and 4 illustrate globes of which the upper surfaces have been shaped so as to direct the light toward the street instead of allowing the light from the upper hemisphere of the customary ball globe to go toward lighting building fronts. Fig. 5 shows a five light cluster equipped with one upright and four pendant globes. All five globes have been designed in this manner and it is thought by many that the arrangement is highly ornamental and should interest merchants and tradesmen who are anxious to draw publicity to their particular street or business block.

In order to determine the effect upon the light distribution, by flattening the upper surface of the globe, the five light cluster in Fig. 5 was equipped with ball globes (four 12-inch in pendant position and one 16-inch upright) enclosing 100 watt lamps and a set of illumination readings taken on a 30-inch plane on a line running through the post. Readings were taken at intervals of six feet and the dotted line curve of Fig. 6 indicates the intensities. With the lamps burning under identical conditions, the flat top globes were substituted and the intensities as measured are indicated by the full line curve in Fig. 6. It will be noted that there is an appreciable increase in illumination out to a distance of ten feet, although there is no appreciable difference in the values beyond. Care was taken to select globes so that the weight and the density of glass was practically the same in both cases.

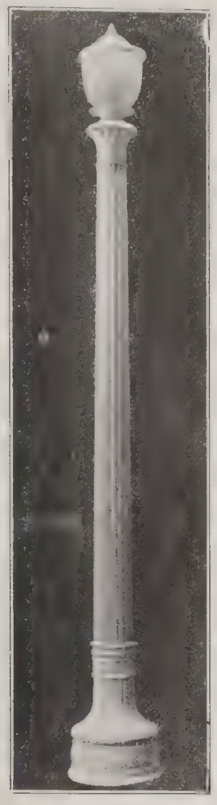


Fig. 8. Single Light Unit With Globe Made of Two Parts.

Fig. 7 shows a flat top globe applied to a trolley pole bracket and Fig. 8 shows a single light unit of which the globe is made up of two parts. The upper flat portion

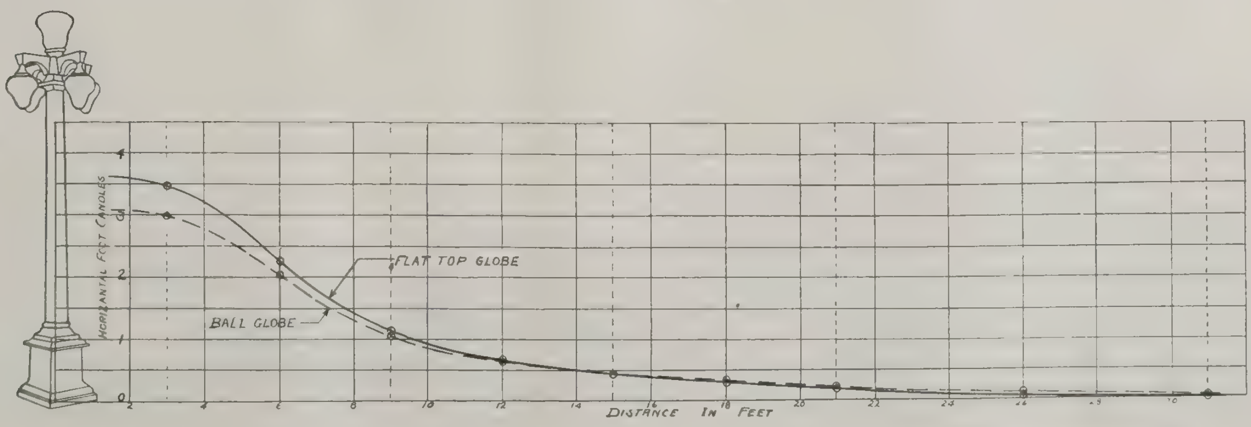


Fig. 6. Photometric Curve Showing Comparison Be-tween Ball Globes and Flat Top Globes.

of the globe is made of dense Opal glass to give maximum reflection and the lower bowl portion is made of diffusing glass of light density to give maximum light transmission. The two parts are held together on the inside by a simple holder.

EXTENISON OF ORNAMENTAL LIGHTING.

Ornamental lighting is becoming more and more a proposition that concerns the municipality. Some time ago it was believed to have been an excellent booster for any band of business men who saw fit to create publicity in their district by installing the so-called "low lighting system." What was demonstrated to be a good thing for the merchant was soon valued by the whole city so that when changes are contemplated and extensions made by our up-to-date municipalities, modern posts, lamps and distributing apparatus is used. The cities of the middle West have taken the lead in this respect.

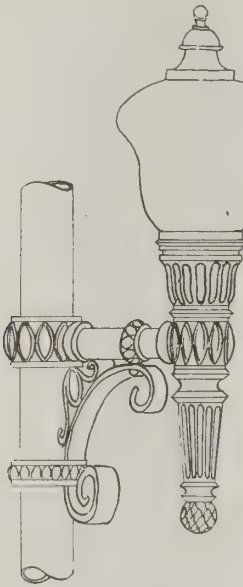


Fig. 7. Trolley Pole Bracket.

The introduction and development of decorative incandescent lighting belongs to America. The Canadians and Mexicans were not long in following suit, however, as in previous articles on the subject of ornamental street lighting, mention has been made of very creditable installations in Toronto and Mexico City. The cities of Europe have been slow to adopt American street lighting. One of the first installations of note is shown in Fig. 9. These posts have been installed by a large London concern on Baker Street in that city and although the present European political disturbances are likely to curtail progress of all kinds, the English cities should eventually find good street lighting to be a paying investment.

The illustrations shown here are presented through the courtesy of the Macbeth Evans Glass Company, whose glassware is used.

Electric Railways in Hamburg, Germany.

According to Consul General Henry H. Morgan, Hamburg, Germany, considerable activity has been shown in the construction of electric street railways in Hamburg during the past two years. In 1912 the Hamburg elevated railroad was built by Simens & Halske (Ltd.) and the General Electric Association. The capital of the company amounts to $3,570,000 and the rolling stock consists of 80 cars. The trunk line, in the form of a ring, is 10 4-5 miles long, from which diverge 7 miles of branch lines. The road passes through 4¼ miles of tunnels, and over 3½ miles of viaducts constructed of iron and stone. The gauge of the road is 1.435 meters (4.7 feet). It will be seen that the trunk line is partly elevated and partly underground.

There are 23 stations on the main line and 12 on the branch lines. The fares are as follows: 2.38 cents for five stations, third class; 3.57 cents for five stations, second class; 3.57 cents for 10 stations, third class; 4.76 cents for 10 stations, second class; 4.76 cents for more than 10 stations, third class; 7.14 cents for more than 10 stations, second class. Before 7 o'clock a. m. tickets for workmen are issued in third class only at 2.38 cents, good for any distance. When purchasing these tickets, return tickets at the same price can be purchased which can be used at any time of the day of purchase. Tickets good for a week for these early trains cost 13 cents, and return tickets available at any hour of the day 27 cents. Commutation tickets for all trains at all hours of the day are also sold at the following rates: For eight stations, third class, $19.04 per year; For eight stations, second class, $26.18 per year; For each further station $1.19 third class and $1.67 second class in addition. A ticket good for any distance at all hours of the day, costs 150 marks $35.70) third class and 200 marks $47.60, second class per annum.

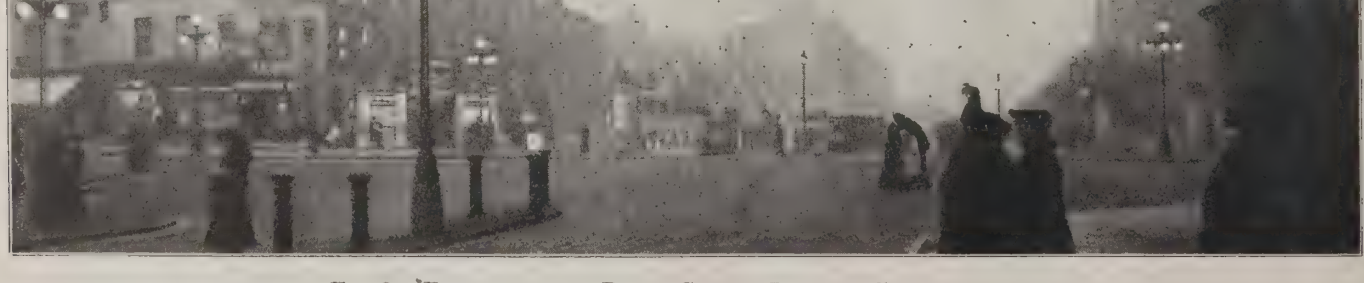


Fig. 9. Electrolier on Baker Street, London, England.

Developments in Designs of Lighting Units and Fixtures.

BY E. J. DAILEY, JR., ILLUMINATING ENGINEER, WESTINGHOUSE LAMP COMPANY.

A VERY complete electric incandescent lighting unit is composed of three essential parts, namely: (1) The lamp, which is the source of light and really the neucleus of the unit; (2) The reflector or enclosing globes for redirecting, diffusing or coloring the light rays; (3) The fixture, which acts as the support for the other parts. As each of these parts is generally made by a different manufacturer, the development of the unit is dependent on the development of the separate parts and their harmonious relation to each other. Efficiency and low operating cost have been the aim of lamp manufacturers while ornamentation and adaptability play the most important part in the manufacture of fixtures and reflectors.

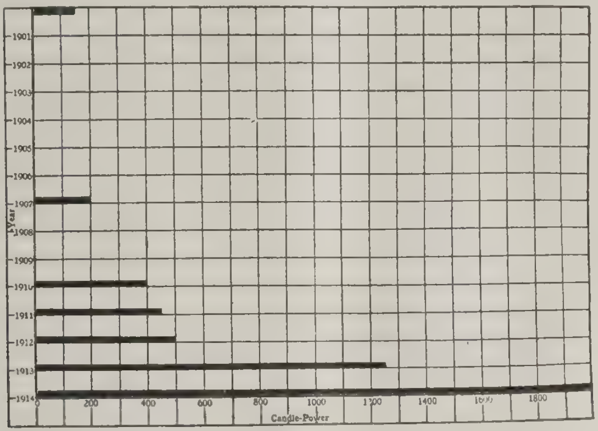


FIG. 1. STEPS IN CANDLEPOWER RANGE OF INCANDESCENT LAMPS—ELECTRIC JOURNAL, JUNE, 1914.

The development of the lamp has been more pronounced than the development of the other parts, as it is the most essential of the whole unit. If increase in sales of this type of illuminant can be taken as a criterion, the development has been remarkable. The total increase in sales of domestic incandescent lamps alone from 1907 to 1913 is almost 60 per cent[*]. Further, it is estimated that out of 347,000 new residences erected within the reach of a central station during the year of 1912, 275,000 or approximately 80 per cent[*] were wired for electric service. All new services run, in one year to old residences, is estimated to be 10 per cent of the total number of old residences that ought to be using and can be wired for electric lighting. Again, when we realize that the consumption of tungsten lamps during 1913 was approximately 80 per cent of that of all other incandescent lamps compared with 10 per cent for the year 1907, we can more fully appreciate the rapid advance made in the development. No other single piece of electric apparatus has done more toward advancing the use of electric current than the tungsten lamp. It is therefore, quite natural that it should form the basis from which fixture and glass manufacturers work, and each advance made by the tungsten lamp involve or influence an improvement in fixtures and glassware.

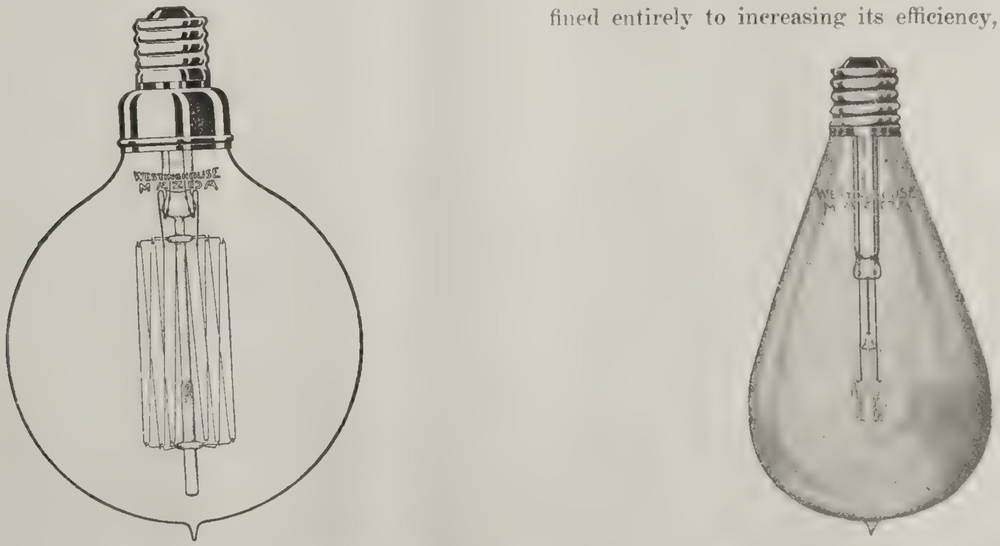


FIG. 2 AND 3. CONSTRUCTION OF VACUUM AND GAS FILLED TUNGSTEN LAMPS.

The continued and remarkable increases in efficiency and quality of light, especially in the high candlepower units, has made this lamp of particular interest for interior lighting. These improvements in efficiencies have been obtained without any sacrifice of life, which is still maintained to average 1,000 hours. It is manufactured in classes that are subdivided and sub-classified in such a way as to meet the most intricate requirements of the general public. Developments within the last year have extended the range of candlepower considerably, so that there are now available tungsten lamps of candlepowers of from less than one to approximately two thousand. The chart shown in Fig. 1 gives graphically the increases in range of candlepower of incandescent lamps.

The development of the light source has not been confined entirely to increasing its efficiency, life, and ruggedness, but the machinery used in its manufacture and methods employed have been so perfected that it is now possible to place tungsten lamps on the market at reasonable prices, which are being continually and almost periodically reduced. The quality of tungsten lamps is very uniform; the filament

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[*] Report of Lamp Committee National Electric Light Association 1914.

Appreciation is expressed for the courtesies of The Edward Schroeder Lamp Company for photographs shown herein.

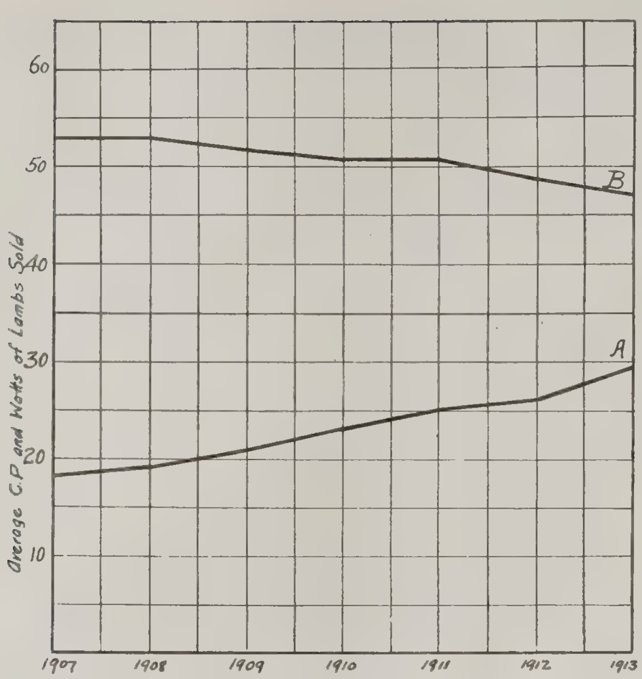


Fig. 4. Candlepower and Watts of Total Annual Sales of Incandescent Lamps (N. E. L. A.—1914).

has been made stronger, its position in the buld and its supports have been improved, chemicals have been introduced into the lamp to prevent or delay the appearance of blackening and to improve the efficiency. Special shaped bulbs are used to facilitate collecting the discoloring particles thrown off from the filament at locations where they do not materially affect the efficiency of the lamp. A decided improvement, one that was necessitated by the increase of efficiency, is the adoption of the coil type filament. Its use permits of confining the entire filament in a small space at the center of the bulb, which arrangement of the filament has the advantage of providing an approximate point source of light which is especially advantageous in reflector design. It causes the light to be distributed more uniformly in all directions, making the reduction factor 90 per cent, as compared with 78 per cent for the old arrangement. In other words, the mean spherical candlepower of the new gas filled lamps is 90 per cent of its rated or horizontal candlepower, while in the ordinary incandescent lamp it is but 78 per cent. This is a big improvement from the consumer's point of view, as it makes the mean spherical candlepower that much nearer equal to the mean horizontal, which is used in rating incandescent lamps.

The concentrated filament surrounded by an inert atmosphere in the high amperage tungsten lamps permits of operation at very high temperature and consequently at high efficiencies. Great progress has been made in the filament drawing process; since it is now possible to draw tungsten wire to an exact size and by mechanical accuracy in cutting predetermine the actual voltage within limits of 2 or 3 per cent. This, of course, effects economies in manufacturing costs and the carrying of the lamp stocks to a marked degree. The improvement, of manufacturing lamps of the proper size and correct voltage for lines on which they are to be operated, increases with the rapid increase in the general use of the lamp. The color value of the new lamp closely approaches daylight, each improvement in efficiency has brought it closer to this goal, which naturally is the ideal condition.

With the introduction of color screens artificial daylight can be obtained with improved tungsten lamps for an expenditure of current equal to 1/5 or 1/6 of that required to produce the same results, using ordinary tungsten lamps. Figures 2 and 3 show the difference in construction of the ordinary and the improved tungsten lamps. Figure 2 is the 400 watt lamp of the multiple type with its filament mounted in a round bulb and stretched over a number of anchors to cover considerable space. Figure 3 is the improved 400 watt lamp with the filament mounted in a straight sided bulb surrounded by an inert gas, and concentrated in a small space.

There is a growing tendency towards using a small number of large units rather than a larger number of small units. The improvements in incandescent lamps has been

Figs. 6 and 7. Steps in Development of Lighting Fixtures.

the means of increasing this demand for higher candlepower lamps as is shown by the accompanying curves in Figure 4. Curve (A) shows the increase in average candlepower per lamp sold per year from 1907 to 1913. Curve (B) shows the decrease in average watts per lamp for the same period. The increase in candlepower is relatively large while the decrease in watts per lamp is slight.

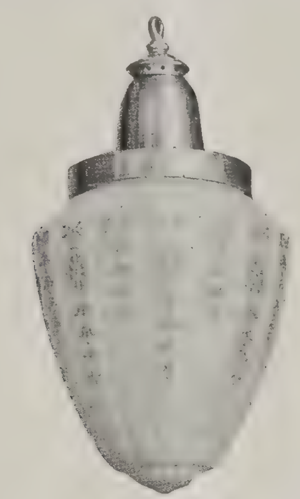


FIG. 8. FIXTURE FOR LARGE HIGH CANDLEPOWER TUNGSTEN LAMP.

The increase in popularity of the indirect and semi-indirect lighting systems is also a big factor in increasing the demand for higher candlepower lamps. With proper choice of fixture, the large sizes can be used for lighting interiors of either high or low ceilings. In direct systems they are effective for high ceiling locations such as stores, auditoriums, armories, hotel lobbies, or industrial plants. Where ceilings are low they are suitable for use in semi-indirect or indirect fixtures. Their adaptability and simplicity are causing them to forge ahead of electric and gas arcs that heretofore were used in such locations.

Each increase in efficiency of the incandescent lamp brought with it a corresponding increase in intrinsic brilliancy. To offset this and to further increase the usefulness of the lighting unit, necessitated the development of the reflector. As a result, there is on the market at present an unlimited number of designs of reflectors which may be divided under two headings, totally enclosing and semi-enclosing mediums. These may be further subdivided into commercial and ornamental classes. The chief aim in the development of commercial reflectors has been to obtain high efficiency and reflection with sufficient diffusion to make the light uniform. In bowls, globes, spheres and stalactites, translucency, low absorption and good diffusion are desired. Where ornamentation is desired, urns or other decorative pieces, to produce an attractive appearance of good color and having good diffusing properties, have been designed. Efficiency in the reflecting and diffusing glassware, while of much importance, is in many instances becoming secondary and is giving place to appearance and adaptability to surrounding conditions.

While it is understood that in lighting installations of the better sort, the fixtures and reflectors are especially designed and specified by the architect or decorator to harmonize with the architecture, it is also recognized that fixtures or reflectors especially designed involve a considerable expense, which is an item of very great importance to many persons in influencing the selection of lighting equipment.

It is interesting to follow the steps in the development of the present day lighting fixture from the torch light of a stick of wood, to wick in oil, candle, gas, and finally, electric incandescent lamp. Figs. 5, 6 and 7 illustrate steps in the development of lighting fixtures. Fig. 5 shows a four-arm gas chandelier with its arms supporting the light in an upright position. Fig. 6 shows a four- arm electric chandelier of the same type. Fig. 7 shows a four-arm electric chandelier with lamps in a pendant position. The introduction of larger and more efficient lamps, together with increased competition has tended to decrease the number of arms used in fixtures for commercial use, however, many of the early designs are still popular in residence lighting. By co-operation, the decorator, architect, the fixture and reflector manufacturers have developed supports for the light source, that fulfill all the requirements of utilitarian merit, appearance and of moderate cost.

Convention of Southeastern Section N. E. L. A. at Isle of Palms.

HE second annual convention of the Southeastern Section of the National Electric Light Association, held at the Isle of Palms near Charleston, S. C., August 19 to 21, was attended by about 100 members and guests. A program providing for four working sessions and the presentation of eleven papers and reports was carried out much after the order found so satisfactory by the parent body, namely, the reading of a few papers at any one session, so as to give ample time for a full and free discussion. All attending took advantage of this arrangement, as shown by the nature of the discussions presented in abstract in this report.

In what follows, no attempt will be made to give more than a general idea of subjects presented by papers, since these papers are available in printed form and merit careful reading in full. Some of these papers will be presented in the next issue of *Electrical Engineering,* it being the aim at this time to give as completely as possible the important points taken up on the convention floor and the views of members as expressed in discussions.

FIRST SESSION.

The first session on Wednesday (Aug. 19,) was opened with an address of welcome by Hon. John P. Grace, mayor of Charleston. Mayor Grace was introduced by P. H. Gadsden, president of the Consolidated Railway and Light Company of Charleston, and after paying a few remarks to the benefits of electricity as a civic force, touched upon the early electrical development of his city. Only 20 years ago the city of Charleston operated its street cars by horses, while today modern systems of transportation and light and power distribution exist and the city has experienced a marked growth as a result. In the words of Mayor Grace "Charleston is now wide awake, due to its dose of electricity."

Following the address of welcome, the president of the section, Mr. T. W. Peters, gave the usual presidential address. His remarks were brief, dealing in the main with recommendations for the carrying on of future work. He advised that all present committees be retained to complete work under way and that a permanent secretary be elected who can be held responsible for the carrying on of association work between times of holding meetings. He referred to the present European war and expressed the opinion that it will result in certain benefits to the South on account of the fact that more finished products will be exported, representing a greater Kw.-Hr. demand on all central stations. He said that more attention will be paid to home industries, and those that are strong will continue if not increase their electrical demands.

On account of the absence of Norman B. Hickox, author of a paper scheduled for this session, entitled, "Commercial Electric Advertising," this paper was read by A. A. Wilbur, of Columbus, Ga., secretary of the section. The advertising value of the electric sign to its owner, and to the community at large as an advertising medium; together with the best ways of promoting the business by central station managements were outlined as representing common practice in securing sign business, all being condemned but one. The best method as outlined by the author, included the handling of sign accounts for customers of good credit standing, spreading the cost of sign, erection and maintenance over a period of months and recommending only the best makes of signs. Those taking part in the discussion were: Wm. Le Portes, Charleston Consolidated Railway and Light Co.; G. K. Hutchins, Columbus Power Co.; C. H. Andrews, North Carolina Public Service Co.; C. A. Collier, Georgia Railway and Power Co.; G. W. Wygant, Tampa Electric Co.; C. M. Young, Columbus Power Co.; R. L. Lindsey, Durham Traction Co.; J. M. Martin, Banner Lamp Works of G. E. Co., and C. M. Benedict, Charleston Consolidated Railway and Light Co.

Mr. Portes referred to good results of signs as business pullers, and agreed with the author of the paper that unjust sign competition as far as manufacturers are concerned should be prevented by the central station. In Charleston, payments for signs may be spread over one year, and in such cases thus far only two customers have failed to meet payments. Sign campaigns are conducted about every six months, so that customers who are slow in being closed are eventually sold signs.

Mr. Hutchins did not favor competition by cheap sign builders and expressed the opinion that most central stations men feel the same way and should be willing to prevent cheap construction, since such signs kill the sale of good signs.

Mr. Andrews (Greensboro), said that a good sign business is being secured on a basis of 6 cents wer Kw.-Hr. A sign, good by day as well as by night is most desired by his customers. He favors the sale of signs for cash, offering the rental of signs and partial payments as a special proposition. Where a company furnishes service to other small towns, the advertising value of signs to the company in its home town was emphasized as means for promoting signs in the other towns.

Mr. Collier (Atlanta), in answer to a question by Mr. Andrews as to the effect of white way systems on installing signs, said that an experience of three years, since the Atlanta white way was installed, seemed to indicate that the white way helps to sell signs. People are brought to the well-lighted streets and merchants take advantage of the fact by displaying an advertising message as a roof sign along the streets most traversed. Roofs facing the streets in Atlanta that have white ways are well filled with signs.

Mr. Wygant (Tampa), outlined his success in arranging with city officials for the installation of signs of large sige. He prefers a cash sale for signs but grants terms when necessary. The sign and white way business has gone hand in hand in Tampa and decided success with both has been experienced. A campaign is to be carried on in November.

Mr. Young (Columbus), emphasized the need of good construction and spoke in favor of a flat rate only for signs when centralized. He was not in favor of flat rate for signs in outlying districts.

Mr. Lindsey (Durham, N. C.), agreed with Mr. Young on stable construction. He said that 100 signs have been installed in Durham during the past 18 months ranging in price from $60 to $2,000, a good showing he believes for a town of about 18,000.

The final paper of this session, entitled, "The Central Station's Greatest Opportunity—the Electric Vehicle," was presented by F. Nelson Carle, advertising manager of the General Vehicle Company, Long Island City, N. Y. This paper treated the subjects under the following subheads: Incomplete presentation and inadequate co-operation; future of electric in the South; central station a recognized Leader; initial service; offpeak earnings; a definite plan important; building from the ground up; load factor possibilities. Methods of handling trucks and securing the business was the main point at issue, much data and many suggestions being advanced to place the truck proposition squarely before the central station from the manufacturer's standpoint.

The paper was discussed by E. D. Craig, president of the Savannah Electric Garage and Tire Co.; C. H. Bell, Electric Storage Battery Co.; E. C. Deal, North Carolina Public Service Co.; H. M. Dunwody, Baker Electric Vehicle Company.

Mr. Craig (Savannah), referred to success of light delivery wagons in Savannah, stating that a 600-pound wagon now in operation has run 49,000 miles at a cost of $50 per month, delivered as many as 630 packages per day and replaced three single horse wagons. It has saved the user $115 per month for 34 months.

Mr. Collier (Atlanta), compared the sales methods of gas and electric truck manufacturers and asked why the latter could not render the service and show the desire for business by shouldering the selling and financial responsibility in the same way as done by the gasoline truck companies. He compared the energy used by truck equipment, showing that in many cases where the industrial load is available that the truck business does not appear attractive.

C. H. Bell (Atlanta), supported the position of the truck manufacturer and showed how, with the help being given in selling trucks, they should be a profitable and desirable load.

E. C. Deal (Greensboro), pointed out that the present electric truck situation is one that must be worked out on a basis that will justify the securing of this business and along the same lines as other business that has been created and is now found profitable. He said that a good sized truck is equivalent in return to about one mile of an average street car line, yet the cost of the latter is far greater.

Mr. Collier (Atlanta), in further discussion said that the maximum charging return on the 200 electric pleasure cars in Atlanta is about $15 per month for a consumption of 425 Kw.-Hrs. per month. This earns a rate of about 3.25 cents. The average charging bill is about $7.00. The pleasure vehicle charging in Atlanta is not off peak by reason of certain load factor conditions.

SECOND SESSION.

The second session was opened Thursday morning with a paper on, "Telephone Communication in Relation to High Tension Distribution," by E. S. Moorer, of Western Electric Company. This paper took up the details of protection for telephone lines when run on power transmission line poles or towers. The different effects of the power circuits were explained and best practice as to construction of lines and operation outlined.

Among those discussing this paper were: C. M. Young, Columbus Power Company; G. K. Seldon, Southern Bell Telephone and Telegraph Co.; C. H. Bell, Electric Storage Battery Co., and C. H. Andrews, North Carolina Public Service Co.

Mr. Young (Columbus, Ga.), described the telephone system used by his company in connection with high tension power transmission. This line is 75 miles long with taps taken off at substations. Over a part of the distance it is strung on a wood pole line carrying 12,000 volts, with transpositions every 625 feet. Over the rest of the distance the steel transmission towers are used with transpositions at every tower. Horn gaps are used on the insulators of the tower line and a reduction of insulator troubles brought about. The telephone service is satisfactory.

Mr. Seldon (Atlanta, Ga.), took up telephone line and power line construction from standpoint of the telephone company and said that more trouble was due to static effects than to magnetic induction and that the former effect was felt on telephone lines half a mile from power lines. Also it was brought out that the longer the telephone line the greater the disturbance, and that loaded circuits are effected more than non-loaded circuits. He advocated co-operation in line construction to cut down causes of disturbances.

The second paper of this session, entitled, "Feeder Voltage Regulation," by A. D. Fishel, Westinghouse Electric and Mfg. Co., was read by E. A. Thornwell, in the absence of the author. The paper took up economy due to constant voltage on feeders, explaining that greatest drop occurs at time of peak load. Different types of regulators were described and shown by illustrations.

The following discussed the paper: W. J. Pollock, Charleston Consolidated Railway and Power Co.; C. M. Young, Columbus Power Co.; Frank Godfloy, Florence Electric Utility Co., and H. A. Orr, Southern Public Utilities Co.

Mr. Pollock (Charleston, S. C.), outlined the commercial reasons for need of constant voltage and explained that good results are secured on his system by use of Terrill regulators at plant and feeder voltage regulators.

Mr. Godfloy (Florence, S. C.) explained the use of transformers with voltage taps and special switching arrangements so as to take care of variations in voltage at certain periods, due to connection of large loads on a transmission line.

Mr. Orr (Anderson, S. C.) uses hand-operated, single phase regulators when selling power to cities and towns where the voltage fluctuation is not excessive. He favors the use of a pole type of regulator that can be used on a small load and believes manufacturers would find a ready sale for a 2 Kw. size, capable of regulating the voltage within 2 or 3 per cent.

Mr. Young (Columbus, Ga.), in answer to a question, said that the placing of lightning arresters on the pole with with a pole type feeder regulator should be good practice, as with pole type transformers.

The report of the membership committee showed 61 class A and 133 class B members, with a total membership for the section including classes D and E of 222. The finances of the section were reported in good condition, with money in the treasury after paying bills.

The last paper of the session on "Recent Developments in Incandescent Lamps," by T. W. Moore, and Henry Schroeder, of General Electric Co., took up a brief review of the manufacture of lamps since Edison's first type of 1877. The details of the newer lamps were explained, and especially the changes in construction of the tungsten vacuum lamp and the features which make possible the new gas filled high efficiency tungsten units.

This paper was discussed by, T. W. Moore, General Electric Co.; J. M. Martin, Banner Division of G. E. Co; C. H. Andrews, with Carolina Public Service Co.; F. S. Godfloy, Florence Electric and Utility Co., and J. S. Bleecker, Columbus Power Co.,

Members and Guests Attending Convention Southeastern Section N. E. L. A. at Isle of Palms.

Mr. Moore (Atlanta), asked for an expression from members as to effect of high efficiency lamps on free renewals and how companies are exploiting new lamps. This question was answered by Mr. Bleecker through the statement that he did not believe in free renewals of any type of lamp. He favors handling the lamp business on the basis of any other electrical device operated by central station, explaining his position by saying that the central station occupies much the same position as the physician; he should diagnose and prescribe but not be a druggist, yet there is no objection if the physician uses a certain druggist's blank in writing prescriptions. He believes in brief that the central station should do all possible to encourage use of all apparatus, but handle it in no way.

The author of the paper in closing made the statement in defense of free renewals or renewals at a low cost that more sockets could be kept in operation and a sufficient extra number over no renewals to offset the cost if placed on a proper basis.

PUBLIC POLICY SESSION.

A session held Thursday evening was devoted to matters of public policy. A paper was read by J. S. Bleecker of the Columbus Power Co., entitled, "How, When and Where, or a Few Irregular Thoughts on Regulation." In this paper Mr. Bleecker discussed the variables entering into the questions of rates and fair return on investment as having a bearing on when and where regulation should begin. He favors the position taken by the Georgia Railroad Commission in regulating matters, and read in part from its decisions. He gave it as his opinion that the Georgia commission is handling its work in an able and intelligent manner.

Mr. J. E. Bigham, Tampa Electric Co., presented a written discussion to Mr. Bleecker's paper, stressing some of the points taken up. He referred especially to the decision of the Georgia Railroad Commission in the case involving the central station companies of Macon, Ga., and complimented the attitude of the commission. As regards rates of return he referred to other industries that are not regulated, and showed that rates of return are much higher than 6 or 8 per cent, that allowed the public utility companies. He approved state regulation but said that state management was dangerous.

The report of the public policy committee in the absence of chairman P. S. Arkwright, president of the Georgia Ry. and Power Co., was presented by Mr. J. S. Bleecker, of Columbus. The committee indorsed the opinion of the Georgia Railroad Commission on competition between public service companies in the same district, as set down in a recent decision and offered a resolution to make plain the position the association takes. This resolution was passed in executive session.

THIRD SESSION.

The session on Friday was opened with a paper entitled, "A New Method of Indicating and Recording River Stages," by MacDougal Dexter. In the absence of Mr. Dexter the paper was read by the secretary. An automatic recording device was described as used by the Columbus Power Company for river gaging. The device is designed on the principle that the pressure necessary to exclude the water from a tube with one end under water is proportional to the head of water above the submerged end of the tube. The device is said to be very accurate, simple and of decided practical value.

Following this paper, Mr. S. A. Sewall, editor of the N. E. L. A. *Bulletin,* delivered an address on N. E. L. A. activities. Mr. Sewall took up the work of the parent body in a general way, pointing out the valuable features to individual members and companies. He touched upon work to educate the public to know what good service is and mentioned the aid that can be secured by holding the loyalty of employes. "The advertising by spoken words complimentary to the company," said Mr. Sewall, "is of more direct value than any newspaper or booklet advertising." He urged co-operation among companies and agreement on standards of construction in order to inspire confidence in those who have reason to compare the practices of different companies. In closing he referred to the progress in the past and predicted a greater development for the immediate future.

The remainder of this session was opened to discussions and proved a most successful feature of the program. A continuation of any discussion on papers presented at other sessions was permitted, as well as discussions on any topics of interest. The main part of the time was taken up in discussing the sale and handling of the new high efficiency Mazda lamps. Mr. Geo. Wygant, of Tampa, opened the subject by describing a successful campaign of picture show front lighting, in which 18—75; 5-1,000 and 18—400 watt lamps are used. These lamps have given an average life of 800 hours. He plans to use the new 200 watt in competition with the 3 mantel gas arc and the 300 watt against the 5 mantel gas arc. He has already been successful in driving gas arcs away from the theater front lighting, and believes he will eventually handle all this business. He also believes he can replace a number of 150 vacuum type tungstens with the new gas filled 200 watt lamps. No free renewals on tungsten lamps are given in Tampa, and it is not probable that any proposition other than an arrangement to install and clean, with payments spread over a short period will be offered.

The effect of free renewals was variously discussed, it being the general opinion that free renewals of lamps of increased candlepower and greatly reduced watt consumption is out of the question and can not be expected.

New fields for the large sizes of lamps were mentioned, including yard lighting about factories and mills, in indirect lighting fixtures for theaters, department stores, store front lighting, etc.

Mr. Bleecker, of Columbus, referring further to the sale of lamps by central stations, developing further his position as exemplified by the physician. He said that in China the physician is paid while the patient is well, when sick the fee stops. In the same way the central station secures a revenue only as long as the customer is satisfied. He believes that the physician is expected to furnish more than a prescription—he must use the stethoscope and hack-saw. A similar action may be justified in connection with certain lines of the central station industry.

T. J. McMannis, Edison Lamp Works, G. E. Co., gave some interesting comparisons of the load represented by one of the large size gas filled Mazda lamps. One 1,000 watt lamp brings in a revenue equal to charging an electric vehicle, lighting a small sized sign, or operating a small motor. Mr. McMannis outlined the nature of advertising to create a demand for electrical apparatus, placing the cost of same as equal to the cost of building a modern battleship.

ENTERTAINMENT.

The entertainment details worked out for the Isle of Palms meeting were conceded by all to be the most elaborate and most enjoyable of any meeting yet held. Credit for all this goes to W. W. Fuller, the genial general manager of the Isle of Palms Traction Co. The features arranged for and carried out included a boat excursion about the Charleston harbor and a visit to Fort Sumpter on one day, and a visit to the Navy Yard on the next day. Arrangements were made so that all were admitted to both the Fort and Navy Yard and all points of interest visited. On the boat excursion refreshments were served, a band and a vocal soloist provided through courtesy of General Electric Company, Westinghouse Electric and Mfg. Company, and Electric Storage Battery Company.

NEW OFFICERS ELECTED.

The following officers were elected at the executive session held Friday morning at the close of the third regular session. President, J. E. Bigham, assistant treasurer Tampa Electric Co.; first vice-president, W. A. Belcher, president Cordele Electric Company, Cordele, Ga.; second vice-president, C. M. Benedict, Charleston Railway and Light Co; secretary-treasurer, Geo. H. Wygant, Tampa Electric Co. Executive Committee, C. D. Flanigan, Athens, Ga.; W. E. Mitchell, Birmingham, Ala.; C. I. Day, Jacksonville, Fla.; H. W. Plumber, Asheville, N. C.; Alfred Wallace, Columbia, S. C.

At this session the position the association takes in regard to regulation matters and relations with the public, was expressed in the following resolution which forms a part of the convention proceedings.

Whereas, one of the objects of this association is to establish cordial and beneficial relations with the public and

Whereas: regulating commissions have been established by the public in many states for the same purpose, now therefore,

Be it resolved: that it is the sense of this association that we indorse as sound in principle those expressions of the Railroad Commission of the State of Georgia looking towards this end which reads in part as follows:

"We do not believe competition can ever be a consistent and proper regulator of rates and other conditions in the public utility field. We earnestly believe that it would be wise if the legislature would prohibit the building of duplicate public utilities * * * prior to issuance by commission, of certificates of public convenience and necessity."

NEW PRESIDENT SOUTHEASTERN SECTION OF N. E. L. A.

Mr. J. E. Bigham, the newly elected president of the southeastern section of the N. E. L. A. is assistant treasurer of the Tampa Electric Co. He was born in the state of Ohio, 1877, and educated at Pennsylvania State Normal College. He was first associated with the American Bridge Co., and served in various capacities in the operating department on structural work. He next went with the American Tin Plate Co., in the operating department, leaving this company to serve in the Spanish-American war. During the war he was on detached service as clerk to a regimental commander. After the war he returned to Terre Haute, Ind., in 1901, to take a position with the Terre Haute Electric Co. He remained with this company for five years, leaving to take the position of assistant treasurer in 1906 with the Stone and Webster Organization at Paducah, Ky. He was transferred to Jacksonville, Fla., in 1909 and to Tampa, Fla., in 1910, with the Tampa Electric Company, where he holds at the present time the position of assistant treasurer.

J. E. BIGHAM, NEW PRESIDENT SOUTHEASTERN SECTION N. E. L. A.

Mr. Bigham is well known among southern central station men and has taken an active interest in association work during the past three years. He is a member of the Tampa Board of Trade, Elks Club, and German Club, and actively associated with commercial interests in Tampa.

The Dixie Club Meets at Atlanta, and Plans to Entertain Jobbers' Association at Birmingham, Alabama, in November.

The Dixie Club, which is an organization of Southern Electrical jobbers, met in convention at the Hotel Winecoff, Atlanta, Ga., August 14 and 15. Representatives from a number of important Southern cities were present and general conditions effecting the electrical jobbing trade in the South discussed. A result of the meeting, as one jobber expressed it, was to learn that competitors do not always have horns. Oscar C. Turner, president of the Turner Electric Supply Company, Birmingham, Ala., is president of the Dixie Club, and T. A. Burke, sales manager of the Atlanta office of the Western Electric Company, secretary and treasurer.

The next meeting will probably be held in Birmingham, Ala., in November of this year, in connection with the annual meeting of the Electrical Supply Jobbers' Association, to be held in that city. Mr. Turner is in charge of arrangements for this meeting, which will be attended by some 350 jobbers from different sections of the country.

All works of quality must bear a price in proportion to the skill, time, expense and risk attending their invention and manufacture. Those things called dear are, when justly estimated, the cheapest. They are attended with much less profit to the artist than those which everybody calls cheap. A disposition for cheapness and not for excellence of workmanship is the most frequent and certain cause of the decay and destruction of arts and manufactures.—*Ruskin, in Union Electric Bulletin.*

New Business Methods and Results

Representing Interests of Central Stations, Electrical Jobbers, Dealers and Contractors.

Securing the Small Lighting Consumer.

In the eagerness to secure large contracts, the central station new business manager often overlooks the possibilities of much good business represented by small consumers. In every city there are thousands of persons now burning oil and gas who would prefer the electric light, and could and would use it, if it were available to them. We refer especially to those who are living in small houses, most of them tenants, families whose individual consumption would necessarily be small, but which might amount to a very respectable sum in the aggregate.

Under certain conditions, such business would be quite profitable to the central station, since it can usually be reached with very little distribution expense, as most tenement house districts are in close proximity to a distribution line and dwellings are close together, thus requiring a minimum of labor and material in making service connections. The addition of such load would therefore reduce the distribution expenses per unit of output, and hence aid in the development of the entire field.

There is, moreover, a distinct advantage in simply increasing the number of customers, even if served at a very small profit, since every additional user adds to the popularity of the service. Some of these small consumers will grow into larger ones, and in making a change in residence, most of them will demand electric wiring, and in this and other ways, will aid to bring about the day of universal electric light.

There are but two obstacles in the way when soliciting this business. One of these is the cost of wiring and the other the cost of current. As we have stated, the majority of these potential customers are renters. The dwellings are not wired, and the owner will not, and the tenant cannot make the required improvement. Various schemes have been suggested, such as having the tenant agree to a small increase in rent in consideration of the owner wiring the premises, but these have met with but indifferent success. Change of tenants is too frequent to make this proposition sound attractive to the landlord, and most tenants will naturally reject even the suggestion of larger rent, although it is in consideration of improvement, for it is usually felt that in the long run they are paying for the improvement.

Foreign companies have solved this part of the problem quite successfully, doing the wiring at their own expense and renting it to the consumer at a rate that will pay interest on the investment, and gradually wipe out the principal, after a term of years, further payments on the wiring then being waived. This plan has never appealed to American companies, perhaps largely because the business in the larger centers is in such a rapid state of expansion that it is taxing the public lighting utilities to provide physical equipment to supply the rapidly increasing demands and because the central stations in the smaller towns are not, as a rule, sufficiently well organized to command the capital necessary to go into this kind of business. That the proposition will eventually pay there is no question.

The relative cost of wiring has also a very direct bearing on this subject. There has been a tendency in this country to give the insurance interests a pretty free hand in specifying the materials and construction to be used in electric wiring and a disposition on the part of the inspection departments to stiffen the requirements to such a point as to raise the cost of wiring small dwellings above the amount that the owner would pay or the company feel like investing. It is to be remembered that we are here considering the problem of the very small consumer, who would need light in perhaps but from 3 to 5 rooms, and in order to be able to offer him an attractive proposition, it should be possible to wire these rooms with molding and drop cords, or equivalent construction, at a cost of from \$10 to \$15 complete, including tungsten lamps. The fixed charges on such an investment should not be over \$0.80 to \$1.20 per year at the most, and a rental charge of 15 to 20 cents per month would amply provide for this and also for the retirement of the principal in about 8 years.

It is not our purpose to criticise the rulings of the Underwriters in what is said here, but simply to call attention to the fact that in order to develop this business we should be free to use the most inexpensive construction, without of course, unduly increasing the fire hazard. The risk of fire from lamps and matches is so much greater than that from even the cheapest of electric wiring that it would seem to the interest of the insurance companies to co-operate to the fullest extent in standardizing inexpensive construction among this class of customers.

Besides the wiring question, we have the problem of providing a satisfactory, adequate, and attractive rate for current. It is indeed a problem to serve the small consumer at a rate satisfactory to him, and yet at the same time profitable to the company. The rates at present charged for residence meter service in this country are not too high, and yet there is a great deal of small business that they will not secure. It seems that the solution of the problem therefore, lies in reducing the cost of service. It is a recognized fact that for small consumers the fixed charges are by far the largest item. Next to this is the cost of meter reading, accounting, billing and collecting, which will probably run from 12 to 20 cents per customer per month. The cost of supplying the current is a small part of the service.

If, therefore, instead of charging for current consumption, the demand be limited and a charge made according to that demand, the cost of service could be greatly reduced. In addition, meter reading would be eliminated, the accounting simplified, and by rendering bills in advance, practically do away with the expense of collection and adjustment. In general, any company is far better prepared to render service to a small consumer at a rate consisting of a flat rate based on the demand, plus a small rental charge on the wiring.

Mr. S. E. Doane, in his paper at the recent N. E. L. A. convention, gave a large number of instances in which this plan is in successful operation in European countries, resulting in phenomenal expansion and intensive development, such as is seldom met with in the United States. In one town of but 160 houses, 95 per cent of them are connected to the lines. Towns of 30,000 inhabitants yield upwards of 4,000 customers. The number of customers where such plans have been adopted, have doubled in from two to four years. The wiring is done very simply and inexpensively, either with twisted cord, or with twin conductors protected with lead or brass covering, something on the order of conduit or metal molding, but much less expensive. This conductor is sometimes buried in the plaster walls, but is more often run exposed, being fitted around basebeards, window frames and picture molding, so as to be inconspicuous, and finished to match the room decorations.

The rates are also very low or rather are adapted to the use of very small installations. The flat rates for 10, 20 and 30 watt tungsten lamps are respectively 16, 24 and 24 cents per month, including rental for the wiring. The guaranteed consumption is low, being from $2 to $4 per year. In some of the cities, the customer pays for the current one year in advance, receiving a card with 12 coupons, one of which is detached each month and left at the collecting office of the company, thus relieving the central station of a large amount of bookkeeping, billing and collection expense.

The development of business among small consumers in this country while not carried nearly to the extent that it is abroad, has yet received some attention. A great many companies are now prepared to assist prospective customers in financing wiring altho no plans have been successfully introduced to cover the case of rented property. During the past few years, a large number of central stations have reported large increase in numbers of consumers by the use of the excess indicator. Very little of this business could have been secured otherwise. The Hartford (Conn.) Company has been the pioneer in the use of the controlled flat rate, and developed the business to a point where the annual revenue is $11 per capita. In Pennsylvania a number of small cities have greatly increased their load. In the anthracite region electricity is now used on this basis in a large number of miners shacks, dwellings that have only 3 or 4 lights apiece. In the South, favorable reports have been received from Augusta, and Columbus, Ga., Greensboro, N. C., Jacksonville, Fla., and others. In these towns the poor white and negro population is large, from 30 to 60%. These people are poor and cannot afford much money for light, but they must have light of some kind and should use electric light. The excess indicator is enabling the lighting companies to reach a great many of them, and if combined with a cheap wiring proposition adaptable to rented property, should help to reach a great many more. A. G. Rakestraw.

There's a Difference.

When the surplus of a privately owned utility corporation gets into the red ink column, it goes into bankruptcy. If a utility owned by the municipality fails to earn its expenses, they raise the tax rate—and everybody chips in to help the city sell a commodity at less than cost.

COMMENTS FROM READERS.

W. O. Vickery, Transmission Superintendent, the Trinidad Electric Transmission Railway and Gas Company, Trinidad, Colorado, Discusses a Good Field for the Central Station Engineer and a Means of Co-operating With Manufacturers, Jobbers, and Dealers to the Benefit of All and Especially to That of Central Station Customer.

The economical production, transmission and distribution of electric power has been the chief study of the central station managers for the last ten years, while utilization by the industrial power consumer has been neglected. It is doubtful if the accounting committee of the National Electric Light Association who made their report and recommendations to that association in the year 1908 on the eight main divisions in accounting realized at that time that they were opening the way for the central station manager to maintain a utilization department, with efficiency engineers at its head. It is also doubtful if they ever realized or thought the central station should have such a department for the promotion of electric power use in the industrial field.

From the accounting standpoint, the seventh division, or "new business," should cover all expenses in connection with promoting the use of electric power. While this is true in securing a new customer, still the promotion of electric power use is further brought about by showing the already connected consumer the most efficient way to utilize power, in point of power consumption and service, for then the customer acts as a new business agent for the central station. There is no better advertisement for the central station than that resulting from a satisfied customer. It is therefore evident that the proper utilization of electric power leads to new fields and customers, and since the central station managers are making a very thorough study of the production, transmission and distribution of electric power, it is reasonable to assume that they are better fitted to take up the proper utilization of such from the consumer's standpoint.

The efficiencies of lamps, motors and electric apparatus have heretofore been left to the manufacturers, which is very natural and proper, but the proper selection, erection and operation of such apparatus should be turned over to those who are familiar with local conditions and have made a study of the requirements. Heretofore, in the purchasing and installation of electric apparatus, too much attention has been given to first cost. Better service can be expected of one unit, which has been properly selected and installed, than two like units, when one is used as a relay, improperly selected and installed. Each unit may have a high rated efficiency at its proper load but if such units are not of the proper size and properly installed, the combined installation efficiency is bound to be low.

Central station managers have begun to realize that efficiency engineers are just as necessary in the sale of electric power in the industrial field as production and transmission engineers are necessary to deliver the power to such fields. With this realization and due consideration of the N.E.L.A. standard classification for the distribution of such expenses, which expenses come under the head of "utilization," the large power companies and central station managers have given proper attention to the selection, erection and operation of his customer's apparatus. This in turn has brought about a marked increase in power consumers in the industrial field, which consumers formerly generated their own power or used steam driven units. With results realized on this account and by the division of production, transmission and distribution, into two departments, with a specialist at the head of each department, it has been found that there is a field for the power application engineer, which has resulted in the organization of the "utilization department."

At the beginning of power application in the industrial field, central station managers were content with the work of the new business agent to promoting the use of electric power in such fields, which agent acted as new business manager and looked after "utilization" in a general way. The trouble here was with such a combination man. At that time the new business manager had not awakened to the actual realization that he should consider only the actual requirements of the customer, instead of selling all the power he possibly could, whether it was actually needed or not, with such procedure oftimes leading to dissatisfied customers and sometimes the loss of a customer.

Only one man seems fitted for the head of a department of "utilization," or "power application," namely, the efficiency engineer. Such a man must be capable of passing upon all engineering matters and must of necessity have the full confidence of the central station manager. The central station manager himself may assume such duties, providing he has the time and is fitted for such work. It is always preferable that a third party be called in when passing upon engineering matters of the larger installations; but the third party should consider only the requirements of the consumer and the operations connected therewith, keeping in mind at all times the best method for keeping down the consumer's power consumption and paying due regard to the first cost. It may not seem reasonable that the central station should bear the expense of investigations, etc., pertaining to the customer's installations, with a view of lowering the customer's power bill, but such is a very profitable stand for the central stations to take, since in the long run it increases the power consumption of the consumer by a continuity of operation of connected apparatus and the additional load which is added by satisfied customers.

In addition to the duties of the efficiency engineer or third party, as outlined, he should act as the intermediate between the consumer and manufacturer or salesman of the apparatus, when new apparatus is being bought. It is never the aim of the jobber, manufacturer or salesman to sell any apparatus not suitable for the requirements, but rather than lose the sale, nevertheless, it has been done and is still being done. It is done because neither the customer, salesman, etc., know the conditions under which the apparatus must work. A great many mistakes are made by salesmen selling the thing which is easiest sold and not the thing which has some merit. This is very true when apparatus is sold to work in connection with other makes of machinery. He is willing to attach his motor without question to any kind of pump, compressor, hoist, etc., without pointing out the good features of certain types or makes. The salesman consoles himself with the thought that his apparatus is all right and he has made the sale. When misfits occur in this manner, the electric manufacturer blames the Compressor Co. and vice versa. The ultimate results are that the central station gets the blame for high power rates or poor service. We cannot help but refer here to the farmer who saw an advertisement on motors, which advertisement gave a cut of an A. C. motor and starter. The farmer having corn crushers and other machines to drive forthwith ordered a motor as advertised, which motor and starting apparatus were received and set up by the farmer. In due time, connections were made between the starting apparatus and motor according to accompanying instructions. After working two or three days and losing a few nights' sleep trying to get the motor started, the farmer wrote the people who sold him the motor, and a representative was sent to investigate. Upon arrival at the farmer's place, he learned that the nearest electric line or power house was sixty miles away, and that there was not even a telephone line to connect the motor to. This, however, is a very exceptional case, but illustrates the fact that sales are made without due regard to the customer's requirements.

When the jobber, manufacturer or salesman receives inquiries from customers for electric apparatus, and learns that such apparatus is to be connected or operated from central station lines, he should advise the central station manager of such inquiries, who should in turn look up the consumer and ascertain his wants and make such recommendations as may be proper. On the other hand, if the central station manager learns that one of his present connected consumers, or a prospective customer, is contemplating additional electrical apparatus, he should immediately get in touch with such parties and make a very thorough examination as to the load, the division of unit load and assist him in selecting the size and type of apparatus best suited. The central station manager, in making his recommendations, should do so by specifications only. The manufacturer's name should not be specified by him. Strict attention should be given to efficiencies, however, service should not be sacrificed for efficiency for this, as a matter of fact, is never necessary, since service and efficiency go hand in hand. When selections are made and the apparatus installed according to recommendation of central station manager, he should not hesitate to make any corrections of mistakes which were made by him. This does not mean that he must bear the expense of new apparatus or the changing about of the apparatus on hand, but supervise or engineer such corrections.

There is in addition to proper selecting and installing of electric apparatus used in the industrial field, the proper operation of such apparatus which promotes the use of electric power for other purposes, and keeps up the current consumption on apparatus already installed. It is only by the proper operation and handling of the apparatus that a continuity of operation is assured. Here again the "utilization department" should inspect the customer's installations at intervals and advise the customer of anything which to his mind is out of the ordinary. If large units are operating at half load part of the time, or empty at times, he should ascertain ways or means for correcting such inefficient operation. Automatic starting and stopping devices can be installed for cutting out apparatus when running idle. Every little phase of the customers' installation should be considered and carefully analyzed.

A customer purchasing power never realizes the convenience and flexibility of the central station service, when such a customer's apparatus is at fault and he is compelled to change back and forth from electric to steam or maintain his steam units for auxiliaries. It is here that the central station manager should step in and relieve conditions if possible. It means to the central station more power consumed when electric operations are carried on the year around without interruption by improper handling of the customer's apparatus. The central station manager should feel that he has a perfect right at all times to protect the customer in his purchases and make adjustments with manufacturers or salesmen on any matters pertaining to faulty apparatus when, of course, the customer has asked for this assistance in these matters.

In order to bring these conditions about, it is first necessary that the central station manager cultivate the acquaintance of his power consumers and make them understand that the station is selling power and not apparatus. After he learns that you are not going to charge him for every little service you render in connection with his installation, he will soon learn to depend on you for advice concerning his operations and every well managed station should be prepared to give him the advice he is in need of. This is not to say that the central station should go into the electric contracting or repairing business, in fact they should avoid just such things, but they must be ready at all times to advise the consumer and negotiate for him with the electric contractor or repair man. The majority of electric power consumers know nothing about electric power application and its proper use, hence it is evident that they must be educated and there seems to be nobody better fitted to become instructors than the central stations.

The St. Louis Company's Ideas on Handling Complaints.

The best time to take care of a complaint is before it happens, and the next best time is as soon after it happens as possible.

Our policy has always been to first settle a complaint, after that there is always time enough to settle who is to blame.

We are always willing to admit a mistake. We never wait until the admission must be forced from us, and when righting a mistake we never do it grudgingly.

We rather figure that the average man is slow to complain. We know after years of experience that there are many men who will let a grievance go by rather than say anything about it.

We would prefer to know every grievance, no matter how trifling or who is at fault. Our standing instruction to our complaint department is, satisfy first, then investigate.

We request our customers to always complain if anything seems wrong. We try every way possible to guard against cause for complaint, but workmen and clerks grow tired, after that careless, then the trouble occurs. We personally can not be everywhere at the same time, so we ask if anything goes wrong, tell us, and we will take pleasure in making it right.

Electrical Standardization in China.

According to Consul General Thomas Sammons, of Shanghai, China, there are at present no recognized standard of electric supply in China. In some instances direct current is supplied; in others, alternating of different phase, frequency and voltages. The Engineering Society of China, however, is working with a view to the standardization of the supply, to be followed by some practical and effective plan for the standardization of the materials used in this line. A committee appointed to consider the subject has arrived at the following recommendations and decisions, which have been circulated as widely as possible in Europe and America in order to obtain free and valuable discussions and suggestions:

1. That generation and distribution generally shall be on 3-phase system at 50 or 60 cycles per second.
2. That distribution shall be carried out generally on the 4-wire 3-phase system with grounded neutral at a pressure of 250 volts between 1-phase and neutral, *i. e.,* 440 volts (approximately) between phases.
3. That the standard pressure for domestic lighting and similar supply shall be 250 volts.
4. That when it is not desirable or economical to use a 4-wire 3-phase supply, then a 3-wire system with neutral grounded or a 2-wire system with one side grounded shall be adopted; in all cases the pressure to ground shall be 250 volts.
5. That the use of direct-current systems shall be discouraged and they shall not be allowed for systems involving either over 50 kilowatts in capacity or having feeder of over one-half mile in length.
6. That no fuses or switches shall be allowed in the neutral wire.
7. That where direct-current systems are essential the generation and distribution shall be on the 3-wire system at 500 volts between outers, the neutral being grounded.
8. That the following pressures shall be considered as standards for high-tension transmission: 2,200 volts, 3,300 volts, 6,000 volts. Pressures above 6,600 volts to be as required by local and other conditions.

Miscellaneous News.

The Minneapolis General Electric Co., has secured contracts for wiring 546 old houses during the first six months of this year. Their output shows an increase of 19 per cent over that of a year ago.

The Union Electric Company of St. Louis recently sold 2,403 electric irons in one day. The sale was preceded by special advertising, leading up to a display announcement, and signs displayed on the company's trucks.

The Duquesne Light Co., of Pittsburgh has insured all employes who have been two years and longer with the company, for an amount of two years' salary. The policy is to be paid to the beneficiary in 12 monthly installments. This amounts to the same as a continuation of the regular salary for one year. The insurance is taken out on what is known as the group plan. The maximum amount is $2,400.

An outline of the N. E. L. A. residence service advertising campaign was outlined by Mr. Edkins in the July issue of *Electrical Engineering.* When considering use of this service the question may come up as to whether such material will make the appeal that locally prepared advertising can. In reply, we can say that it will do a great deal through its general appeal. However, some persons cannot be reached through a general appeal alone but require a personal appeal to clinch the sale. Get the residence series by all means! Send every piece of literature to all possible customers who ought to have electric light by reason of being able to afford same, but do not depend upon the service to get the business without that personal touch which only the man who knows the prospect can give. Create the general interest, then drive home the personal appeal.

Questions and Answers from Readers

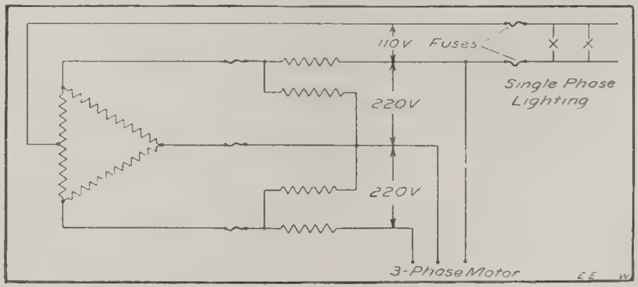
Readers are invited to make liberal use of this department for discussing questions, obtaining information, opinions or experiences from other readers. Discussions and criticisms on answers to questions are solicited. However, editors are not responsible for correctness of statements of opinion or fact in discussions. All published answers and discussions are paid for.

SINGLE PHASE LIGHTING FROM 3-PHASE CIRCUIT.

Editor Electrical Engineering:

(474) Please advise if the lighting load taken from a 3-phase, 3-wire, 220-volt circuit at 110 volts as shown will register on the meter properly. If not explain why.

F. W. Gibson.



Connections for 110-Volt Lighting from a 220-Volt Circuit.

CALCULATION OF FLUX OF MAGNET.

Editor Electrical Engineering:

(475) Please publish in the question and answer columns a formula for calculating the flux due to current in a coil of wire on iron core, such as a motor field pole. The core is 1.0 inch long and 1.0 by 1⅜ inch in section. The winding consists of 50 feet of No. 21 wire and connected to a 110-volt circuit. Calculate for a current of 1.0 amperes.

Robert Hafner.

OVERLOADING INSTRUMENT TRANSFORMERS.

Editor Electrical Engineering:

(467) Please explain why a polyphase watthour meter will run slow when the instrument transformers happen to be overloaded.

W. J. R.

GRAPHIC METER ON FLUCTUATING VOLTAGE.

Editor Electrical Engineering:

(477) In case of large variations of voltage, where a graphic meter is used, will the peak indication be raised if the voltage is low at times of maximum load and lowered in case the voltage is high at this time?

Canadian Reader.

DERIVATION OF WIRING FORMULA.

Editor Electrical Engineering:

(478) The Standard Handbook for Electrical Engineers gives the following formula for calculating the size of wire required by induction motors and from the examples used to show its application, it is inferred that the formula holds good for transmission over short distances:

Cir. mils $= [P \times 746 \times L \times K \times 1.5] \div [n \times pf \times E \times e]$

Where P is rating in Hp.; L distance to motor in feet; n motor efficiency; pf power factor; E impressed voltage; e drop in the wiring and K a constant which varies with the power factor and for a 3-phase, 3-wire system is 11 for 100 per cent power factor and 17 for 80 per cent, with intermediate values for power factors between.

Another formula which is much used and found in standard works is as follows:

Cir. mils $= [W \times D \times K] \div [E^2 \times \%$ line loss$]$.

Where W is watts delivered; D distance of transmission; K a constant varying with power factor and for a 3-phase, 3-wire system is 1080 or 100 per cent power factor and 1690 for 80 per cent, with intermediate values for power factors between; E the voltage at point where energy is consumed and % line loss, a percentage of watts delivered.

When using these two formulas for the same set of conditions different results are obtained. For example, suppose a 20 horsepower, 220-volt induction motor of 88 per cent efficiency and 80 per cent pf, is to be connected 40 feet from a switchboard allowing a drop of 3 volts and the size of wire is required. By the first formula.

Cir. mils $= [20 \times 746 \times 40 \times 17 \times 1.5] \div [.88 \times .8 \times 220 \times 3] = 32{,}753$ cir. mils, or No. 5 wire.

By the second formula we have:

Cir. mils $= [(\sqrt{3} \times 220 \times 51 \times .8) \div .88] \times 40 \times 1690] \div [220^2 \times 1.2] = [17{,}600 \times 40 \times 1690] \div [220^2 \times 1.2] = 20{,}400$ cir mils = No. 6 wire.

As shown, there is a difference of $32{,}735 - 20{,}400 = 12{,}353$ cir. mils, which is considerably more than the difference between any two wire sizes.

In the last formula W is taken as $\sqrt{3}$ E.I. × pf and % loss of W in the same way. Please explain through what factors this difference in result comes and why the value of K in each formula differs. Would like also to see a derivation of the second formula.

E. F. S.

WHY DOES GENERATOR BURN OUT?

Editor Electrical Engineering:

(479) The writer has a 60 Kva. Westinghouse, A. C. generator, rated at 1,100 volts, 27.2 amperes per terminal, 2-phase, 60 cycle and 900 r.p.m. The machine has been rewound for 2,200 volt operation and when placed in operation has burned out at the rate of once a week. One phase is loaded heavier than the other, could this cause the burn out? Please furnish information on this trouble and how to tell if the rewinding was properly done.

F. A. T.

Measuring Single-Phase Power From a 3-Phase Circuit. Ans. Ques. No. 458.

Editor Electrical Engineering:

A 3-phase or poly phase meter when properly connected in the circuit will measure accurately all the power that goes through it, regardless of whether the load is balanced or not. It would therefore register power consumed by lights or single phase motors, no matter what phase they are fed from. We assume of course that the poly-phase meter is in good adjustment and that it is not overloaded.

Transformer Losses. Ans. Ques. No. 459.

It is true that the core loss of a single-phase transformer installation is smaller than that of a 3-phase installation of the same capacity. Especially is this true in a small sized installation. Consider for example a 45 KW. single-phase transformer, and three 15 KW. transformers arranged in a three-phase bank to give the same capacity. The core loss of the 45 KW. transformer is 300 watts while that of the 15 KW. transformer is 120 watts each, or a total of 360 watts. It is therefore apparent that the iron losses alone are 20 per cent greater for the single-phase transformers. In installations exceeding 300 KW. there would be very little difference in the transformer losses, and the 3-phase supply would certainly be more desirable.

Arrangement of Lamps for Special Display. Ans. Ques. No. 461.

Forty dry cells connected four in series and ten series groups in parallel should be satisfactory for burning 50 6-watt, 6 volt lamps for four hours. Three large storage batteries connected in series would be cheaper if they are available.

In answer to the last part of this question I would say that it is not possible to operate the bank of 3 lamps in multiple in series with the banks of ten in multiple. The three lamps must either be left out entirely or the bank must be increased to ten. In case the 3 lamps are left out entirely, 11.7 ohms resistance would be required. If this bank is increased to ten and connected in series with the others, 8.3 ohms resistance will be required.

Rankin.

Arrangement of Lamps for Special Display. Ans. Ques. No. 461.

Editor Electrical Engineering:

Mr. K. W. H. must realize that a current drain of 50 amperes for 4 hours is far beyond the limit of efficient primary battery operation and the current cost of his display will therefore be high. If he had 110 volt service available he could, of course, connect 54 lamps in three banks of 18 lamps in multiple, the three banks being connected in series. He would then use 50 × 6 watt × 4 hrs. = 1200 watt hours or 1.2 Kw. Hrs. at a cost of not more than 15 or 20 cents. Primary wet cells are out of the question for three reasons: Their voltage is low and a great number would be required; the voltage would not hold up under such severe service; and their first cost is too high.

A storage battery would be much more serviceable, provided Mr. H. has the facilities for charging and can use the battery for other purposes so as to justify his original investment. Such a battery would consist of three cells and have a capacity of 200 ampere hours, at the 4 hour rate. The cost of the battery would be in the neighborhood of $50.00.

Consider now the last alternative, namely, dry cells: $W = E^2/R$ or $6 = 36/R$, whence $R = 6$ ohms per lamp. The resistance of 50 lamps in multiple = 6/50 = .12 ohm. Assuming 5 cells in series, each cell would then supply current through .12/5 or .024 ohm. By experiment it has been ascertained that one dry cell will last 4 hours through a .75 ohm resistance with a drop in voltage to 0.75. Hence, .75/.024 = 31 cells in multiple will be required. For a 6 volt service it is usual to supply 5 cells in series, having an initial working voltage of approximately 7.0 on this heavy service so that at the end of the four hours' operation the voltage will have dropped to 5 × .75 = 3¾ volts, and the lamps will not be burning very brightly. It is evident then that for this heavy service 31 banks of 5 cells in series will be required, or 155 single cells, the cost of which will be in the neighborhood of $25.00. Inasmuch as the required number of wet cells will cost very much more than even this high figure, the writer's first statement would seem to be justified. Even with 31 cells in multiple, as seen above, the end voltage will be rather low, and for best lighting effect, a few more cells should be used, bringing up the total to say, 35 in multiple. It might be pointed out that the use of 6 watt lamps with dry cells is rather unusual. Ordinary 2 watt, 6 volt lamps are supplied. When using these the number of cells required in multiple could be divided by three.

Referring now to the second question, the lamps are connected as shown in Fig. 1. Since the lamps in each bank are in multiple, the drop across each bank will evidently be the same as the drop across a single lamp, or 13 volts. Also since W = IE, the current required by each lamp will be I = W/E = 5/13 = .385 amps. The current required by each of the first five banks equals 10 × 5/13 = 50/13 = 3.85 amp. and that required by the bank of 3 lamps = 15/13 = 1.16 amps. We can now figure the equivalent resistance of each bank as follows: E = IR or R = E/I, whence R for first five banks = 13/3.85 = 3.38 ohms. and R for last bank = 13/1.16 = 11.27 ohms. Representing diagrammatically in Fig. 2 each bank by its equivalent resistance, we can find the total resistance of the circuit as follows: 5 × 3.38 + 11.27 = 28.17 ohms. The total voltage drop = 78 volts, then the total current = 78 /28.17 = 2.77 amps. The first five banks require 3.85 amps., hence the lamps in those banks will not burn brightly. The lamps in the last bank require only 3 × .385 = 1.155 amps., so these will burn out. Hence a resistance must be put in multiple with the three lamps sufficient to bring the resistance of this bank down to the value of the other banks. Letting the value of this be (x), then 1/3.38 = (1/x + (1/11.26) or .296 = (1/x) + .089. Thus 1/x = .207 and x = 4.83. Each of the six banks now has an equivalent resistance of 3.38 ohms or a total of 6 × 3.38 = 20.28 ohms. and the current = 78/20.28 = 3.85 amperes.

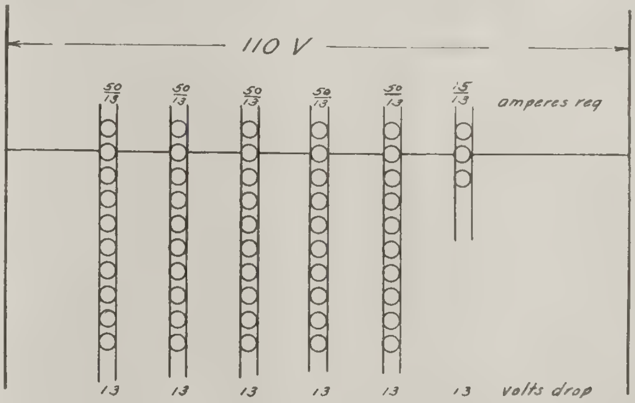


Fig. 1

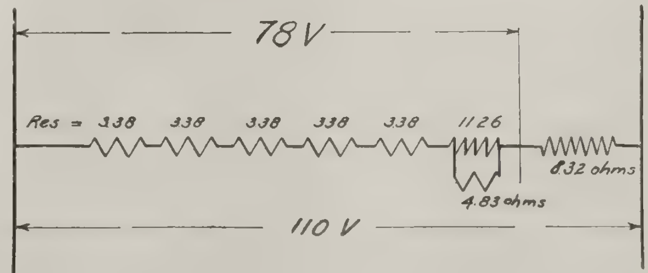


Fig. 2

Figs. 1 and 2. Circuits for Display and Resistance Diagram.

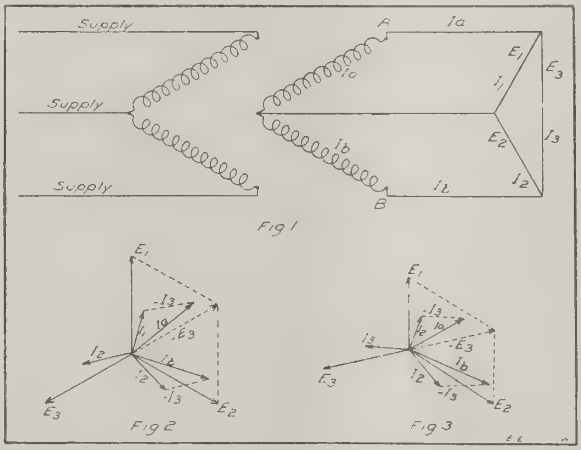
If now we placed these six banks across 110 volts, then 110/6 = 18.33 volts would be impressed across the terminals of each lamp and inasmuch as they are 13 volt lamps they would either burn out immediately or else their life would be very short. Hence, a resistance must be placed in series with the banks of lamps sufficient to consume the extra voltage, *i.e.,* 110 — 78 = 32 volts. The value of this will be 32 /3.85 = 8.32 ohms.

To sum up, then, place a 4.83 ohm, resistance in parallel with the bank of three lamps, and a 8.32 ohm. resistance in series with the lamp line. V. A. Clarke. (Ohio.)

Why Transformer Burned Out. Ans. Ques. No. 463.

Editor Electrical Engineering:

From the data given in question No. 463 of the July issue, there would seem to be no reason for the transformer burning out. When using two transformers of the same size, open delta or V connected, they should carry a load of 0.87 of the combined capacity of the two. Two 20 K.w. transformers, connected in this way should carry a load of about 34 K.w., with full load current through each. With one of the transformers of 30 K.w. capacity, as in this case, they should carry more than this, since the larger one would tend to hold up its voltage better as the load came on. This would change the vector relations somewhat, and cause it to carry more than half of the load, while the smaller one would carry less than half. This is shown in Fig. 3, where E_2 is considered to be slightly larger than E_1, making I_2 larger than I_1, in the same ratio. E_3 would have a value between the two, and would not be exactly 120 degrees from them, as in the case of balanced voltages. $I_1 - I_3$, subtracted vectorially will give I_a, and in the same way $I_2 - I_3$ will give I_b. In this case Ib will be larger than I_a.



VECTOR DIAGRAM SHOWING CURRENT AND VOLTAGE RELATIONS FOR TRANSFORMER CONNECTIONS.

The trouble might possibly be due to the smaller transformer not having the same ratio as larger, and having for this reason a higher secondary voltage. This would cause it to carry more than its share of the load, and perhaps burn out. The explanation of this would be the same as that given for the larger transformer carrying more than half the load.

Fig. 2 gives the vector diagram for two transformers of the same size and ratio, open delta connected, as shown in Fig. 1. In all the figures I_1, I_2, I_3 are the currents through the three-phase load, which is considered to be balanced. I_a and I_b are the currents through the two leads, 1 and 3, and therefore through the two coils A and B.

Proper Connections for Transformers. Ans. Ques. No. 465.

If a voltmeter is available, the simplest method of testing out polarity of coils is to throw the primary across the line, connect two of the secondary coils in series, and test with voltmeter. If the coils have the same number of turns the meter should read twice the voltage of one coil for correct series connection, and zero for wrong connection. If they do not have the same number of turns, connect so as to get the largest reading. Connect the second and third together and try out in the same way, and so on. If the voltmeter is not available, an incandescent lamp can be used. If the correct primary voltage is not at hand, one of the secondary coils may be used as a primary for testing with correct voltage across it. It can be connected to the coil next to it, and tested out in the manner already described.

Large D. C. Motors on 110 and 220 Volt Circuits, Ans. Ques. No. 466.

Large D. C. motors are usually operated on 220 or higher voltages in preference to 110 volts because of smaller line loss, and better line regulation. In the case of changing from 110 to 220 volts, the loss would be reduced to ¼, while the line drop would be reduced to ½ its former value. This would give slightly better operation of the motor, as well as a saving in copper loss and copper cost when constructing the line. L. M. Klinefelter, (Colo.).

Why Transformer Burned Out, Ans. Ques. No. 463.

Editor Electrical Engineering:

In a delta circuit, the line current is the vector difference of the currents in two phases 120 degrees apart. The line current is thus equal to the phase current times the $\sqrt{3}$ Referring to Fig. 1, transformer A must carry the whole current in line No. 1, hence it carries I$\sqrt{3}$. If transformer A is rated at 20 K.w. and 100 per cent power factor, its rated current at 550 volts will be 20,000 ÷ 550, or 36.4 amps. With a 25 K.w. three-phase load of 72 per cent power factor, we get a line current of $I = (25{,}000) \div (.72 \times 550. \times \sqrt{3}) = 36.4$ amps. Thus if the load has a lower power factor than 72 or if it is more than 25 K.w., the 20 K.w. transformer will be overloaded.

In the vector diagram of Fig. 1, above E_1, E_2, E_3 are the voltages that would exist in a delta group of transformers and I_a, I_b, I_c the corresponding currents lagging by an angle O. In the V connection we only have the voltages E_1, E_2. The current I_1 is I_a-I_c and I_2 is I_b-I_c. By referring to the diagram, we see that E_1 and I_1 are out of phase by an angle of $30° + \phi$, E_2 and I_2 by an angle of

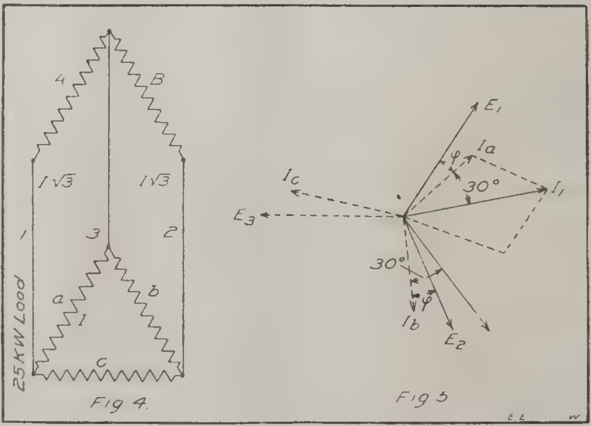


FIG. 1. CURRENT AND VOLTAGE RELATIONS FOR TRANSFORMERS OF DIFFERENT SIZE.

30° — ϕ. For loads of low power factor one transformer operates at very low power factor causing poor regulation while the other operates at high lagging or even leading power factor. With a load of unity power factor the phase difference between current and voltage in both transformers will be 30°; consequently the combined Kva. rating of two transformers in V is greater than that of three transformers in delta to handle the same Kw load by an amount of about 16 per cent.

Proper Connections for Transformer, Ans. Ques. No. 465.

Probably there are four secondary leads on the transformer which may be called A, B, C and D. Connect the primary to the line and with a voltmeter or a lamp test out between A and B, A and C, A and D. Two of these tests will show no voltage. Suppose that A and C show a voltage. Now test B and D; these should show the same voltage as A and C. Connect A to B and test for voltage between C and D. If this shows a voltage, connections are right for series operation. If it tests out no voltage, connect A to D instead of A to B. This will show a voltage between B and C which should be twice that between A and C. If this is the case connections are right for series operation.

R. H. Willard. (Pa.)

New Apparatus and Appliances

High Tension Oil Fuse Cutouts.

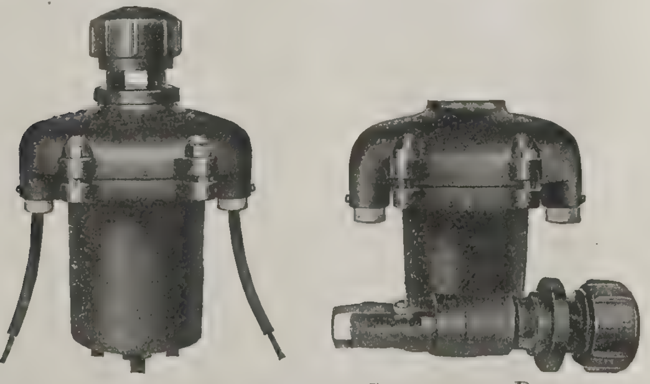
Although there is nothing new in the idea of a fusible wire or strip placed in oil and used as an electrical protective device, the design of these cutouts in the past has been, on the whole, extremely crude and their operation, as a general thing, has been entirely unsatisfactory. After prolonged study and experiment, The D and W Company of Providence, R. I., has developed a new type of cutout in which these defects have been eliminated and its operation under service conditions during a long period, is claimed to be entirely satisfactory. In this cutout, the fusible element is placed under a heavy body of special oil. On the blowing of the fuse the terminals are so arranged that they are forcibly thrown apart and the oil being interposed between them, effectually prevents the formation of an arc. Exhaustive tests have been made under abnormally exacting conditions of large generator capacity and low power factor, and its operation has been so perfect as to prove beyond question its value as a protective device.

The cutout is provided with an effective venting system which prevents any accumulation of pressure within the casing and also the blowing out of any considerable quantity of oil. The oil container is provided with a plug outlet at the bottom which permits the drawing off of the oil when on rare occasions this becomes necessary. Under ordinary conditions of service the oil would not require drawing off more than once in a year or two for such purification.

The cutouts are equipped with flexible cable terminals to which the line terminals may be soldered, thus eliminating any necessity of making complicated connections within the device itself. At the present time three capacities of cutouts are on the market for overhead line construction, of 50, 100 and 200 ampere, 2,500 volt capacity. In the design of these cutouts the safe operative point has been limited to ten times the full load values; thus, the 50 ampere cutout will safely handle 500 amperes, the 100 ampere cutout 1,000 amperes, and the 200 ampere 2,000 amperes on short circuit. Beyond that is an ample safety factor, so that these devices are suitable for all ordinary conditions of commercial service.

Special precautions have been taken to so design the device as to render re-fusing safe for the operator. A lineman can insert a new fuse even when the line is short-circuited, without risk to himself, as the whole device is effectually locked against the blowing of the carrier and the oil, in case of the unexpected blowing of a fuse during the operation of fuse renewal. This is effected by arranging for automatically locking the cover before contact is made with the fuse terminals.

The cutout is not intended for use as a switching device. It can, however, be depended upon to open moderate loads when used in this manner, but is not recommended for that purpose. Three phase types are now being designed for subway service and similar designs for higher potentials up to 13,000 volts.



Figs. 1 and 2. The Oil Fuse Cutout and Details of Fuse Mounting.

A Removable Conducting Jacket for Conductors.

Louis Steinberger, president Electrose Mfg. Company, Brooklyn, N. Y., who is well known for his inventions in the insulator field, has secured a patent on a "flexible electric conductor," which is adapted particularly to trolley conductors of railways. The invention is intended to combine the high conductivity of a copper jacket with the great strength of the steel around which it is wrapped. The conductor as a whole, therefore, comprises a longitudinal sup-

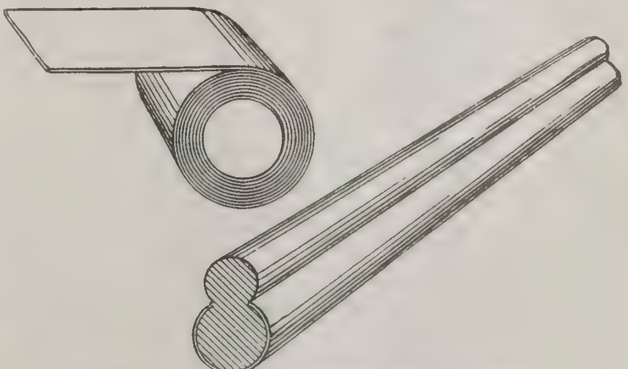


Fig. 1. A New Design of Conductor.

porting member and a removable ribbon of metal with a low ohmic rssistance and provided with a suitable contact surface.

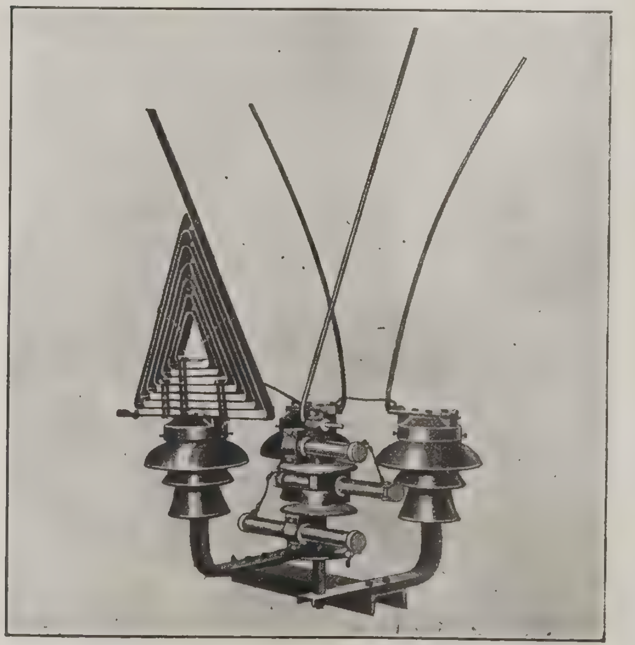
The ribbon may be applied to the supporting wire when the latter is manufactured, or may be placed in position upon it at any time after the wire is suspended; moreover, the ribbon may be cut into any convenient lengths. A worn portion of the ribbon may be readily replaced at low cost. The ribbon carrying the contact face may be applied to compensate for the difference in the co-efficients of expansion or contraction between the body portion of the conductor and the ribbon. Fig. 1 shows the improved conductor applied to "figure eight" wire. A ribbon of copper is bent under and partially around the lower lobe to form a conducting envelope. A second view shows a roll of copper ribbon as used for splicing or patching.

The conductor is suitable for either direct or alternating currents, but for the latter it has a peculiar advantage due to the fact that the copper ribbon involves the principles of the "skin effect." This principle follows from the known fact that alternating currents, and especially currents of high frequency, seek to follow the outside rather than the inside of a conducting body; consequently if the outside is of conducting material of very low ohmic resistance, the conductivity of the conductor as a whole is greatly increased.

A New Lightning Arrester.

To meet the demand for a lightning arrester, embodying all of the characteristics of the Burke series horn gap arrester, but with a resistance in the ground circuit of each phase, the Railway and Industrial Engineering Co., of Pittsburgh, have placed on the market, the protective equipment shown in the accompanying illustration. The arrester consists principally of a triangular choke coil wound with strap copper and a ground horn mounted on a special post type insulator, which supports and insulates from each other and the ground the resistance units.

In the design of the arrester, the two factors which cause a surge to arc the ground are concentrated at one point, that is, an efficient obstruction in the form of a triangular chock coil, and a point of weak resistance to ground in the form of the horn gap. A surge meets its first obstruction at the first sharp turn of the choke coil, opposite which point the ground horn is mounted. Due to this construction the gap to ground may be set 50 per cent greater than the ordinary shunted horn gap and the same protection obtained.



A New Lightning Arrester.

The resistance is of such ohmic value as to limit the flow of dynamic current to approximately ten amperes, should two or more phases discharge simultaneously. It is inserted in the ground circuit of each phase, and is composed of "Koppat." This resistance material is extremely strong mechanically and possesses electrical characteristics which make it particularly adaptable to this service. It is said to have a very low positive temperature coefficient to resistance, conducts current uniformly throughout its entire mass, and is not affected by high frequency discharges, as are many other composition resistances. These resistance columns are so constructed that they may be used in connection with Burke arresters now in service, operating with horns connected direct to ground.

Bryant-Perkins Panel Units.

Some ten years ago a unit construction for panel boards was produced by the Bryant-Perkins Companies of Bridgeport, Conn. A new design of such panel units is shown in Figs. 1 and 2. In Fig. 1 the dissembled panel unit is shown, and in Fig. 2 an assembled panel board showing use of these units.

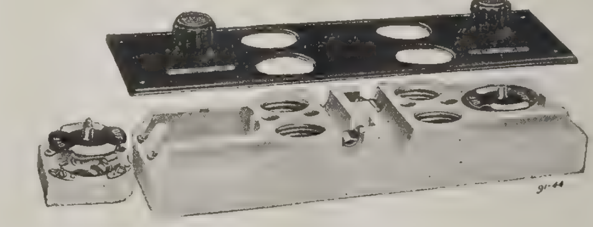


Fig. 1. Dissembled Perkins Panel Unit.

The Perkins panel unit consists as shown of a base which carries all the conductors and connections to the circuits; the two switch mechanisms which drop into apertures in the base, and the cover, which extends across the whole front and is held in place by the switch knobs and fuse plugs. All connections and conductors are concealed and separated from the front of the panel by a continuous sheet of insulated material, so that there are no live parts accessible from the front.

In case a switch mechanism requires adjustment or repair, the cover of the particular unit affected can be quickly removed, and the switch mechanism lifted from its socket. It can then be inspected and repaired without danger of short-circuit and with maximum ease. If it is not convenient to repair the switch it can be replaced by a new one.

From the user's point of view this new panel has many advantages. First of all, it is absolutely safe, which is a point well worth considering, since workmen's compensation acts are in vogue. The fuses are self-indicating and can be replaced by any one without the use of screw drivers or other tools and the attendant danger of using them.

From the contractor's point of view the construction is advantageous not only from the service side, but also from the economical side. With a quantity of these units

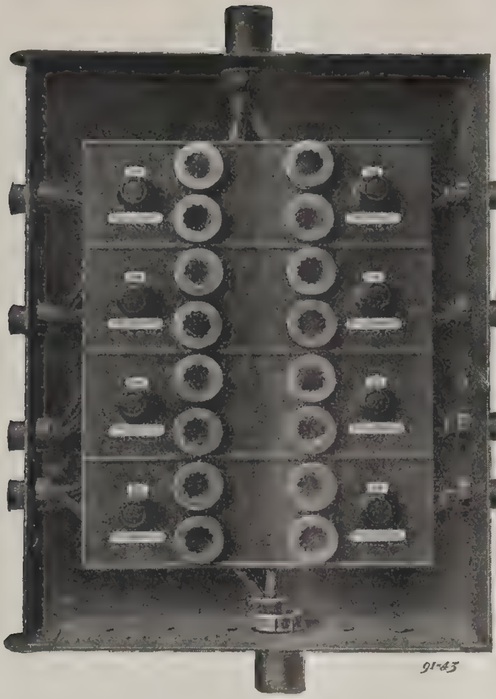


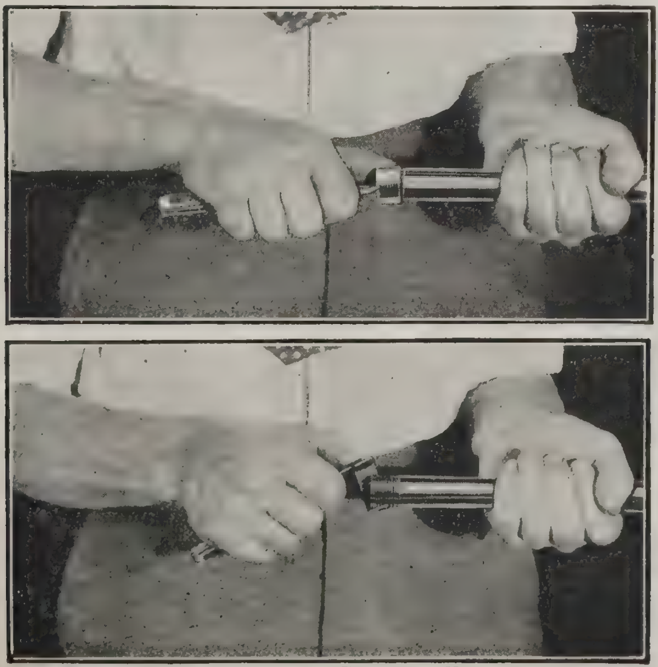
Fig. 2. Panel Board Made up of Perkins Units.

in stock, the contractor is ready to make lighting panels of any size, thus avoiding delays and carrying expensive stocks.

Thread Protectors for Enameled Conduit Pipe.

A new feature in enameled conduit which has been developed by the Enameled Metals Company of Pittsburgh, Pa., should be of great interest to the contractor. During the process of manufacture and before the pipe is enameled, a fiber thread protector is placed over the threads, which entirely protects the threads from filling with enamel, but allows the pipe to be thoroughly coated, both inside and outside without depositing the heavy coat of enamel on the threads. This feature is of very great advantage to the contractor, as it removes the necessity of running dies over the threads.

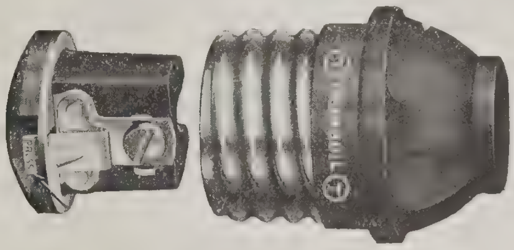
These thread protectors are very easily removed, as shown by the accompanying illustrations. All that is necessary is for the mechanic to make an incision into the fiber and pull away the covering which exposes the threads clean and bright, ready to be screwed into the coupling. Couplings are kept clean from any deposit of enamel by thread protectors placed on the inside of the couplings. These are removed before the conduit is shipped, as there is little danger of the threads in the couplings being damaged in shipment. Clean threads in couplings are fully as important as on the ends of conduit, as they eliminate the trouble of trying to screw a length of pipe into a coupling, the threads of which are filled with enamel.



Fiber Protectors for Conduit Threads.

Swivel Attachment Plug.

The swivel attachment plug shown in the accompanying illustrations has recently been produced by the Trumbull Electric Mfg. Co., of Plainville, Conn. The construction is such that by pressing a catch the bottom drops out and the plug is opened. This catch is also a lock. The plug is made of fire proof material, of ample design, and easy to wire. This plug was shown at the recent Detroit convention of the National Electrical Contractors' Association.



Trumbull Swivel Attachment Plug.

A 100 Hour Electric Lantern.

A design of electric hand lantern has been produced by the Beers Sales Company of 1005 Broad Street, Bridgeport, Conn., for which a life of 100 hours is claimed. This lantern is made of a rolled brass or pressed steel tube and arranged so as to use an ordinary dry cell. A 2.5 candle-power lamp and a suitable reflector and lens makes this device suitable for reading meters, work about automobiles and other purposes where a dependable flash light can be used. This lantern is however more than a flash light, since by means of a suitable contact switch it can be made to give intermittent or steady light. The demand on the battery is about ¼ ampere. When used by automobilists on on motor boats, it will operate on batteries that are no longer efficient for ignition service.

Beers Electric Lantern.

Electrical Construction News

This department is maintained for the benefit of contractors, dealers, manufacturers and consulting engineers.

ALABAMA.

BAY MINETTE. The city is to construct an electric light plant for which bonds have been voted. W. D. Stapleton is mayor and can give other information.

TITRONELLE. The Titronelle Public Service Corporation, which has been recently incorporated, is to build an electric light plant and construct five miles of transmission line. A six ton ice machine will also be installed. G. P. Corey is president and Elliot C. Wells is engineer, both of Titronelle.

FLORIDA.

DETROIT. The Detroit Ice, Light & Power Co., has been incorporated with a capital of $25,000 by F. W. Symmes, M. V. Tracy, C. M. Keep. The company will build an electric and ice plant.

FORT MEADE. The city has recently voted to construct an electric light plant.

PALATKA. The Palatka Light & Power Co., has been incorporated, with a capital stock of $100,000, by P. H. Norcross and Robert L. Hutchison and Lake Jones.

ZOLFO. The Zolfo Electric Co., has been incorporated, with a capital stock of $10,000 to install an electric light plant. The officers are H. C. Merty, President; Fitz Williams, Vice-President; J. R. Roberts, Secretary, and C. A. Skipper, Treasurer.

GEORGIA.

ATLANTA. The United Electric Construction Co., of Philadelphia, Pa., has been given a contract to install electrical equipment and wiring in the building to be erected for the Ford Motor Car Company, in Atlanta.

AMERICUS. The Amercus Public Utilities Co., and the American Power Co., have been combined under the name of the Americus Public Service Co., with L. G. Council, President. One of the plants owned by this new company is to be dismantled and the remaining one will be improved and operated by the new company.

CLARKSVILLE. It is understood that plans are underway for the installation of an electric light plant to be operated by water power. W. T. Proctor and W. L. Polk, of Atlanta, have charge of the engineering work.

KENTUCKY.

BERKSVILLE. The Berksville Power & Light Co., has recently been incorporated by George Greenup and J. P. Smith. A distribution plant will be operated and power secured from a roller flour mill.

HENDERSON. The city will rebuild its municipal electric lighting plant recently destroyed by a storm.

NORTH CAROLINA.

HIGH POINT. The North Carolina Public Service Company is planning to install an ornamental street lighting system in the business district.

SNOW HILL. The city of Kinston, N. C., is considering building a transmission line a distance of 16 miles to furnish electricity to Snow Hill.

WINSTON SALEM. An ornamental lighting system is under consideration for the down town district. The Southern Public Utilities Co., has offered to install ornamental posts on ten blocks in the business section if the contract can be secured which will warrant the expenditure.

TENNESSEE.

CUMBERLAND GAP. The Kentucky Utilities Co., has obtained a right of way enabling it to build a line to the town of Cumberland Gap. Electrical power will be furnished this town, as well as Lincoln Memorial University near this place.

CHATTANOOGA. The Chattanooga Railway & Light Co., has secured a contract for the street lighting for a period of five years. The present arc lamps will be replaced by new nitrogen filled lamps.

CHATTANOOGA. The Chattanooga-Tennessee River Power Co., proposes to install additional equipment in the Hales Bar plant, including three 10,000 kilowatt transformers and switching equipment to operate 420,000 volts.

MARYVILLE. The Aluminum Company of America is to construct a hydro electric plant on the Little River. This company now secures power from the Tennessee Power Company to the extent of $25,000 horsepower; 10,000 horsepower being secured from the Chattanooga and Tennessee River Power Company's Hales Bar plant.

PERSONALS.

MR. W. M. ROSEBOROUGH, southern manager of the Shelby Lamp Division of the National Lamp Works of the General Electric Company, who is now conducting a sales campaign to introduce the new high candle power, high efficiency Mazda Lamp in the South, has recently secured the services of Mr. A. T. Brown as assistant manager. Mr. Brown comes from the Engineering Department of the National Lamp Works, and is thoroughly familiar with the latest development in lamp manufacture. The high efficiency Mazda lamp, in sizes of 1,000, 750 and 500 watts, with other smaller sizes soon to appear, is being favorably received, and, while competing with the arc lamp, is also establishing new fields, such as building exterior illumination and special display lighting. Mr. Roseborough is enthusiastic over the possibilities for this lamp in the South.

MR. J. R. McLAIN, who for a number of years has been connected with the electrical department of the H. W. Johns-Manville Company, New York, died of pneumonia at the Hahnemann Hospital, New York City, July 28. Mr. McLain had many friends n the electrical field, was a man of unusual ability, and held in the highest esteem by all who chanced to know him.

MR. FRANK E. BROWN has become associated with the H. W. Johns-Manville Company, and will act as a special representative, devoting his attention to the further sales development of service meter protective devices. Mr. Brown is well known to engineers in the United States and Canada, as he was for twenty years (1889-1909) Electrical Engineer for the Department of Water Supply, Gas and Electricity, New York City. While in charge of electric affairs for New York City, Mr. Brown was prominent in creating the demand for and in urging the adoption of meter protective devices among the lighting companies of the country.

INDUSTRIAL ITEMS.

THE H. W. JOHNS-MANVILLE COMPANY has established a new division of its electrical department, which will be known as the lighting division. The department will have charge of the company's busness in the well-known Frink and J-M linolite systems of lighting, and will enlarge the scope of the company's business and service in lighting fixtures in general by the addition of new lines. This development now enables the Johns-Manville Company to handle lighting propositions of every size and character.

Sales will be under the direction of Mr. Edward L. Cox, manager. Mr. Cox is well known in the trade through his long connection with the Enos & Watkins Company. Mr. G. Eugene Villaret, who has had wide experience abroad and in this country, will have charge of designs. The new division will be prepared to furnish from stock designs in brackets, pendants, hangers, ceiling fixtures, glassware, etc., to meet practically all requirements. Where special fixtures are desired, the company's long experience and extensive manufacturing facilities, coupled with the service of Mr. Villaret in designing, places the Johns-Manville Company in an exceptionally strong position to serve its customers. The lighting division will be prepared to execute orders for fixtures of all types in all materials, including glass, composition, brass, bronze, etc.

THE SIMPLEV WIRE AND CABLE COMPANY, of Boston, has secured the contracts for wire to go into the new Equitable Building under construction in New York, the largest and heaviest office building yet designed. The specifications to date call for a total of more than 400 conductor miles for distributing electric energy and lighting service throughout the mammoth building.

THE WILCOX ELECTRIC CO., of Birmingham, Alabama, have secured a contract to wire the new Y. M. C. A. Building in that city. Mr. R. E. Wilcox, who personally supervises this class of work, is an electrical engineer of some ability, and is recognized as a contractor who does first class work only. He is a member of the National Contractors' Association, and recently attended the association convention in Detroit, Mich. Mr. Wilcox uses Appleton Electric Company's outlet boxes and fittings.

THE HART AND HEGEMAN MFG. CO., of Hartford, Conn., has secured the exclusive selling rights for the products now being made and sold by H. T. Paiste, of Philadelphia. The line of switches and receptacles made by the former company supplemented by conduit fitting line taken over makes this company one of the strongest of supply manufacturers and distributors.

HOLOPHANE WORKS of GENERAL ELECTRIC COMPANY is distributing catalog 311 on the Ivanhoe Counter Line of metal reflectors and portable fixtures. The revision of this line and the new schedule of discounts shows a careful study of interests of the trade.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., has just issued a bulletin on central station lighting transformers. This bulletin describes the distinguishing features that have characterized Wagner transformers for many years, such as variable voltage taps, patented one piece porcelain outlet bushings, specially designed clamps for holding active material in the case, etc. Explicit directions are given for some of the more common transformer tests that can be made by any central station engineer with the instruments that are usually available.

THE P AND B MFG. CO. has been incorporated with a capital of $5,000. The company will manufacture electrical fittings and heating appliances. General offices and works are located at 306 Manufacturers' Home Building, Milwaukee, Wis. A. H. Patterson is secretary and treasurer.

MR. A. J. EDGELL, of The Society for Electrical Development, has been elected Second Vice-President of the International Association of Display Managers. Mr. Edgell delivered an address at the 17th annual convention of this organization in Chicago August 5.

THE ELECTRIC SPECIALTY CO., of Stamford, Conn., has recently developed a new line of self-starting induction motors. In these motors the usual starting clutch has been dispensed with, owing to the inherent difficulties arising from its use and a special split-phase winding used, which gives a starting torque and overload capacity of 175 per cent or more of full load ratings. Special attention has been given in the design and construction to eliminate all magnetic hum, making the motor especially adapted to musical instrument work and the driving of general household and office fixtures where such noise is objectionable. These motors are built in sizes of from one-tenth to one-third horsepower. The same general type of motor is also built in sizes of from one-sixth to one-half horsepower, with oil ring bearings.

GENERAL INSULATE COMPANY, No. 1008 Atlantic Avenue, Brooklyn, N. Y., announce that Fred'k Steinberger has been appointed sales manager for their middle West territory, with an office at No. 9 So. Clinton St., Chicago, Ill., Room No. 418.

THE H. W. JOHNS-MANVILLE CO. has moved its Duluth office to larger quarters at No. 327 W. First Street, in order to take care of increased business. The new office is on the ground floor, with windows for the display of roofing, pipe coverings, packings, sanitary specialties auto accessories and other products.

THE WESTINGHOUSE ELECTRIC & MFG. COMPANY announces further changes in the sales department as follows: F. N. Kollock, Jr., has resigned as district manager of the Seattle office to accept the position of treasurer and assistant secretary of the Westinghouse Lamp Company at Bloomfield, N. J. W. D. McDonald, formerly branch manager at Minneapolis, has been appointed to succeed Mr. Kollock as district manager of the Seattle office. C. C. Curry has been appointed acting branch manager at Minneapolis to succeed Mr. McDonald.

THE ENGINEERING MANUAL, published by the American Electric Railway Engineering Association is now being distributed. This publication is a compilation of the standards and recommendations adopted by this Association and covers practically the entire field of Electric Railway engineering. The book is in loose leaf form, and consists of 82 sections, fully illustrated with diagrams and working drawings. The loose leaf form of the Manual has been adopted in order that the Standards and Recommendations may keep pace with such additions and alterations as are made at the yearly conventions of the Association. Separate sections may be obtained. The price of the Manual to non-members of the Association is $3.00, binders $1.00 extra.

U. S. LIGHT & HEATING COMPANY RECEIVERS. In the United States District Court in Buffalo, on July 21st, Judge Hazel appointed James O. Moore and James A. Roberts receivers for The U. S. Light & Heating Company, following a case in equity. It was clearly outlined by the court that there should be no interruption in the fulfillment of existing contracts in the prosecution of pending business or in the company's operations in any department.

Mr. A. H. Ackermann, vice-president and general manager prior to the receivership, was immediately apponted general manager to operate the business because of his familiarity with it, and the entire staff of salesmen, engineers, etc., were retained in their former capacities. Mr. Ackermann has issued the following statement to the trade and to the public: "The action recently sustained in the appointment of the receivers for the property of the company was a necessary step to conserve the assets for the benefit of all. With assets of three dollars for every dollar of debt, the company is amply stable, and the court's direction to continue the business is the last proof necessary to reassure the buying public. There are already under way plans for broad financing, and with the return of general prosperity in the country, the U. S. L., more aggressive than ever before, intends to secure its own full share of the business and to continue the manufacture and sale of its special electrical products."

THE NEW YORK INCANDESCENT LAMP COMPANY, of 134 West Fourteenth street, New York City, have been taken over by Ernest W. Boyce, and the business will be continued under the name of the New York Electric Lamp Company, with general offices at 38 Park Row, New York City. Mr. Boyce has been associated with the New York Incandescent Lamp Company from its inception as general manager, and has always given his personal attention to the sales department of that company. The new company will continue to serve its patrons with the "Regent" wire drawn tungsten and "Best" carbon and the "Regenerated" refilled carbon lamps.

The most eloquent, artistic and individual Electrical Advertising Display now obtainable produced by means of the Greenwood Shadow Picture. Any combination. Ask for Designs.

GREENWOOD ADV. CO.

Knoxville, Tennessee. Western Plant at Los Angeles.

CARELS FRERES, of Ghent, Belgium, after two years' work in the United States through W. R. Haynie, 30 Church Street, N. Y. City, has sold some large Diesel engines here, including Phelps, Dodge & Co.—1000 horsepower engines, and the Coronet Phosphate Co.—750 horsepower engines. Arrangements have now been completed whereby the Nordberg Manufacturing Company of Milwaukee, Wis., acquires the exclusive manufacturing and selling rights for these engines in the United States. This was done after Mr. Bruno B. Nordberg, President and Chief Engineer of the Nordberg Mfg. Co., had spent considerable time in Europe investigating the different types of Diesel motors built and with his high standing as a scientific engneer and constructor he decided that Carels Freres' engines were best suited for this work.

W. R. Haynie will be retained as special Diesel representative of the Nordberg Mfg. Co., with offices at 30 Church Street, N. Y. City. Carels Freres were the first people to sell large Diesel engines in the United States, having sold a great many of these large units in the Central Stations and industral plants throughout Europe, including 5—1000 horsepower engines for the Glandstone Graving Docks in England, and these engines have proven very reliable for any class of work, so that the power plant owners in the United States can be assured of receiving only the highest grade of equipment in the Nordberg-Carels-Diesel engines.

MESSRS. J. & C. G. BOLINDERS CO., Stockholm, Sweden, manufacturers of Rundlof's Patent Crude Oil Engines, have, in twenty years development of this engine, succeeded in selling many thousand horsepower in the several countries of the world both in marine and stationary types.

Realizing the great possibilities of industrial development in the United States after a thorough study of conditions by their managing director, Mr. Carl Pape, of Berlin, they have arranged an American Company, THE BOLINDERS COMPANY, 30 Church Street, New York, and are entering into an active campaign for business in the United States.

THE TERRY STEAM TURBINE COMPANY has moved its Cleveland, Ohio, office, in charge of L. G. Finlay, from 710 New England Building to 503 Union Building. The company also announces the appointment of Fidareque Bros. & Sons, of New York and Panama, as representatives for the Republic of Panama and the Canal Zone. Offices are at 15 Whitehall street, New York City.

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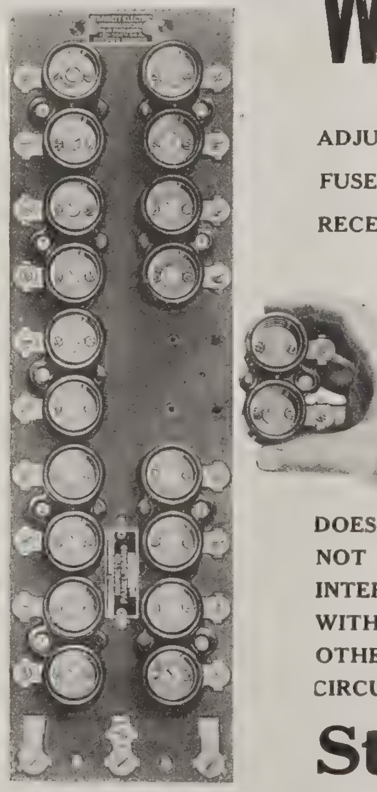

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Devoted to the Generation, Transmission and Distribution of Electrical Energy for Lighting, Heating, Power and Traction.

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Faith in Your Business.

Most people have a tendency to criticise the fellow who hews his ideals a little too close, for as they put it, he "leans over backward" too much. There is considerable logic in this criticism, for the man who holds himself from doing things from fear of being wrong will seldom have a chance to be right. When times are called poor by the average pessimist and money said to be tight, it has been and now is the policy of many interested in public service corporations to curtail commercial activity, or at least cease the solicitation of industrial, agricultural or miscellaneous loads possessing the least feature of speculation as regards profitableness of the business.

Such a policy is either the result of a mistaken idea of the value of commercial activity or ignorance of conditions and factors that make business profitable. The work of the National Electric Light Association along commercial lines has forced a recognition of the fact that a commercial organization is essentially the life of any utility when it is made up of thinking and intelligent men, believing implicitly in their product. It is this organization that must cultivate the kindliest feeling between the company and the consumer and by the increased sale of current and energy consuming appliances must provide the sinews of war—the revenue accrueing as a result of increased energy sale—for payment of salaries, of operating expenses, of construction work, and in fact, all of those items that so readily eat up the revenues of a public utility.

The commercial organization in so-called hard times must furnish the optimism so necessary to all business. This staff of men must encourage the consumer that the utility is going ahead when everything else is wrong. It is the commercial organization,—the business-getting body of men,—that maintains the positions of executives in many cases at very remunerative salaries, those whose purpose it is to direct and operate a utility. It is the business getting organization therefore that is the medium through which the ready cash of the consumer finds its way into the treasury of the utility, and it is the commercial agent who satisfies the "kicker," and holds the customer, assuring him the service rendered is excellent and that the charges are just. Why, then, in so-called hard times, periods of actual financial stringency, or otherwise, is this branch of a public utility the one that actually keeps the mill going, the first to suffer? Why must the policy established by the successful managers of the largest commercial organization in the world, the National Electric Light Association, be set aside, and the encouragement and upbuilding of the commercial organization be overlooked by those charged with the development of public utilities in the south, in the west, on the Pacific coast, or elsewhere? Is it through a misunderstanding of the public utilities and their business, or is it caused by other facts beyond the general knowledge of those on the outside—a lack of faith?

A certain writer has recently said, "There is nothing quite so grand as 'panic faith,' 'faith in your bank,' 'faith in your industries,' 'faith in your governmental representatives,' 'faith in your country' and 'faith in yourself.' Fear nearly always starts with the individual and is nearly always without reason. If everybody would determine to keep his head just now, the greatest prosperity this country has ever known will soon begin to poke out its head. Remember that when you are in a fire it is not safe to stand around idle. A wall might fall and crush you. Get busy with your little bucket of water and help put out the fire."

Let's all find the fire and get busy!

Bureau of Standards Safety Rules.

A general investigation of electrical life and fire hazards, authorized by the Congress of the United States, has been conducted by the Bureau of Standards for over a year. Among other factors in these hazards is that of the operating practice employed and the conduct of workmen about electrical equipment and lines. The study of this phase of the general question has resulted in a code of safety rules for operation which are very widely endorsed by state commissions, operating companies and workmen. The scope and means pursued in collecting and analyzing information, suggestions and existing rules, are explained in an introduction to the rules. An appendix treats briefly of the methods found by experience most feasible for instructing employees and for securing their necessary cooperation. Much information of value has come from a study of rules, accident statistics, and other publications taking up practices in all countries.

The electrical fatalities to workers on or about electrical equipment of lines in this country is very high, not less than 450 during 1913. The prevention of a considerable proportion of these fatalities is readily securable by observance of known safe operating methods. The best practices to reduce these fatalities are outlined in circular No. 49 issued by Bureau of Standards, arranged in simple and convenient rules. Safety rules to be observed in construction, installation and up-keep, are also under preparation by the Bureau. By the combined use of safe construction and safe operating methods, it should be possible for the United States to at least approximate the present comparatively low number of electrical fatalities in several European countries. This subject deserves serious attention and study.

The Bureau of Standards makes the suggestion that great advantage would result to companies and workmen alike by the general adoption in several states of a single standard set of safety rules, which can be revised in accordance with the progress of the art and the combined experience of all the companies and commissions of the country. Thus would every state and every company secure the advantage of the experience of all. Where particular rules do not apply their omission would of course cause no conflict in practice. If it were necessary for any state commission to adopt additional rules, that could be done at any time by special orders. This would be easier and less confusing than to have a different set of rules for each separate state.

It is believed that a certain material reduction in present life hazards to electrical workers can be realized by a careful study, adoption and use of these rules.

Society for Electrical Development to Aid in Securing South American Business.

At the suggestion of interested parties, the Society for Electrical Development is planning to co-operate with manufacturers and others desirous of placing goods before buyers in South America. The following letter has recently been sent out to create interest in this trade:

"While the American manufacturer cannot possibly regard the present condition existing in Europe as in any way a condition to be desired, at the same time, it brings him face to face with an opportunity which he should in all justice to himself take advantage of, namely, the cultivation of the foreign market from which, for the time being, European competitors have withdrawn.

"After the war is over, the European countries will borrow money from the United States and pay back a goodly portion of the money so borrowed for American made supplies of all kinds. This will be the natural result of the cessation of production in Europe, but no one can predict when the end of the war may be.

"At the present time, the great South American market is left open by withdrawal of European competition, and your attention is drawn to the possibilities of that market. If interested, the Society for Electrical Development will be pleased to secure for you whatever information it can, and if you desire literature translated into Spanish for circularizing South American countries, the Society will have that done, charging you the actual cost of such service.

"Another feature to be considered is to what extent our American manufacturers can help each other in the matter of producing electrical supplies heretofore imported from Europe. What, for instance, have you been importing? Possibly the Society for Electrical Development can find an American manufacturer willing and able to make what you have heretofore been procuring from abroad, and if so, we will be pleased to render you this service."

Electricity on the Farm.

The Interstate Light & Power Company, Galena, Illinois, serves a large number of zinc and lead mines throughout southwestern Wisconsin and in the district around Galena. Among the farmers along the company's transmission lines there is a strong demand for electric service, and wherever possible, the company supplies it. The following item from Benton, Wisconsin Advocate of August 7th, refers to a recent installation connected on the farm of John Curwen:

"Although John Curwen lives in the country he has all the modern conveniences of a city dweller. His house and barns are illuminated with electricity, he grinds his feed with an electric motor and uses the same system to turn his cream separator. His wife has an electric flat iron and we presume he is in the market for a motor car. John says he sits in the parlor, turns a little button and the button does the rest."

According to a statement from the U. S. Geological Survey, the copper industry will probably feel the injurious effects of the European war more seriously than any other of the leading American metal industries. During the last five years approximately 50 per cent of the copper turned out by American refineries has been exported, in large part to the countries now involved in the European war

Steam Station of the Virginia Power Co. at Cabin Creek Junction, W. Va.

BY FRANK G. ALLEN, SECRETARY C. O. LENZ, CONSULTING ENGINEER, NEW YORK CITY.

THE Virginia Power Company was organized on September 25th, 1912, for the purpose of acquiring, constructing and operating hydro-electric and steam power properties, transmission lines and other public utilities. The company has acquired the physical properties and water rights of the Dominion Power Company of West Virginia and controls the Dominion Power Company of Virginia and the New River Power Company, of West Virginia. By the purchase of these companies, the Virginian Power Company secured possession of valuable lands and water rights along the New River in the states of West Virginia and Virginia. A steam power station, to be described in what follows, has been constructed at Cabin Creek Junction, W. Va., and a comprehensive electric transmission and distribution station been built.

This station supplies electric power throughout the famous Kanawha-New River Coal District of West Virginia, the second largest coal producing section of the State. This district contains more than 250 operating mines, having a combined output for the year ended June 30th, of 20,203,480 tons of bituminous coal of which 19,000,356 tons, or 94%, were mined in Kanawha, Fayette and Raleigh counties, which counties for the present embrace the principal market for power generated by the company.

The steam power station mentioned is located on the west bank of the Great Kanawha River at Cabin Creek Junction, West Virginia, fifteen miles from Charleston, on the main line of the Chesapeake & Ohio Railway. The station is constructed of concrete foundations with steel and brick superstructure in which there is installed Westinghouse-Parsons turbo-generators, boilers and accessories capable of generating 26,666 electrical horse power. Space has been provided in the station for the installation of two additional units by which the company can increase its generating capacity to 53,332 horse power.

C. O. Lenz, Chief Engineer of Virginia Power Co., and Designing Engineer for System.

In addition to the steam station the company owns and controls three large power sites on the New River, located at Bluestone, Richmond Falls and Hawk's Nest, West Vir-

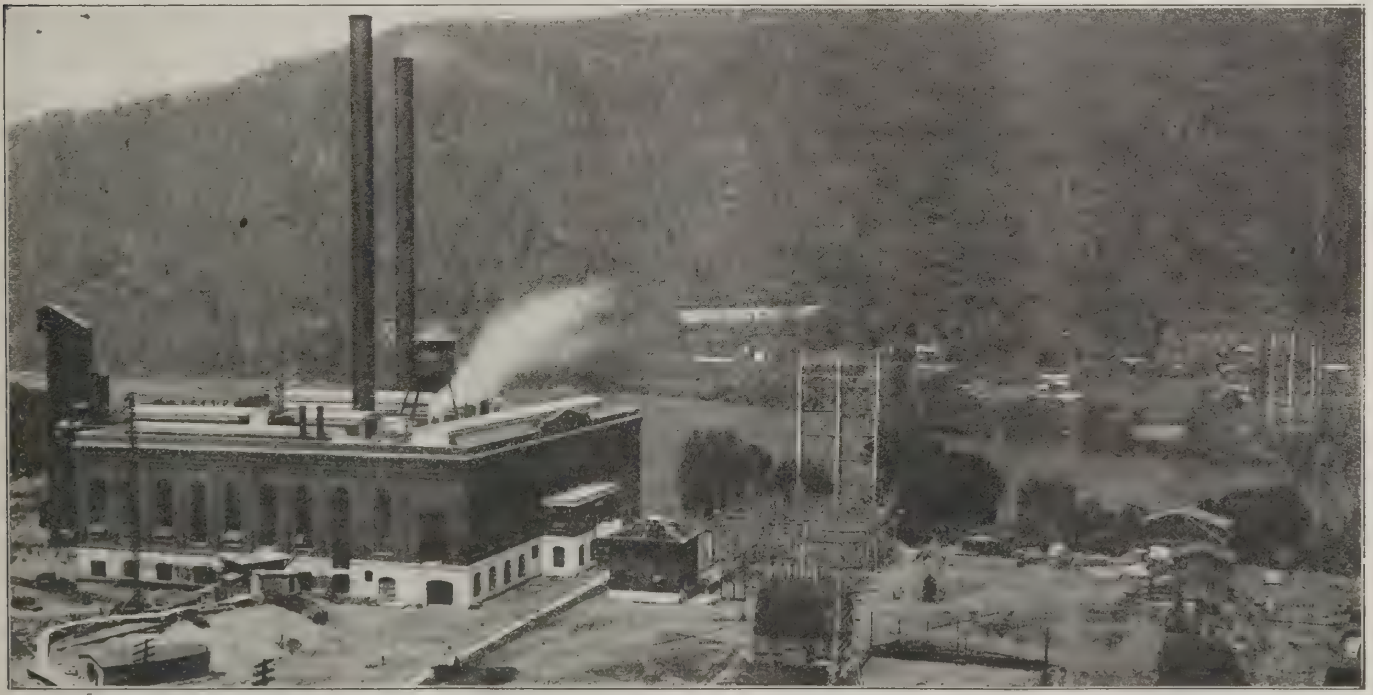


Fig. 1. General View of Power House, High Tension Switching Structure and Transmission Line of Virginia Power Co.

ginia, and several other smaller water power sites also along the New River. The estimated drainage area at the various sites varies from 4,400 square miles at Bluestone to 6,250 square miles at Hawk's Nest. The available power at the three principal water power sites is estimated approximately as follows: Bluestone 125,000 K.W., Richmond Falls, 15,000 K.W., Hawk's Nest 30,000 K.W., giving a total of 170,000 K.W. It is contemplated in the early future that a water power development will be required at Bluestone, West Virginia, where the conditions are favorable for the erection of a dam 140 feet in height with a crest length of approximately 2,000 feet. A dam of such dimensions would extend across a valley connecting two chains of mountains and it is estimated will back water some twenty-five miles up-stream forming a lake with a surface area of about 8,500 acres. The company already owns considerable land and flowage rights in the valley embracing the proposed development which with the above water power sites are considered sufficient, if properly developed, to meet the present power requirements of the mining districts above mentioned, and to do a lucrative business with public utilities and manufacturing industries in Charleston, Huntington and elsewhere.

The Virginian Power Company has commenced operation with a substantial number of customers and a large amount of business contracted for by coal companies operating in the district served. By taking power from the Virginian Power Company, these coal mines have suspended operations of their own isolated plants, inasmuch as it has been established that the purchase of power from a centrally located plant offers greater advantages. There are many difficulties confronting the mine owners in the operation of isolated plants, the securing of competent labor to operate them and a good water supply for boilers having always been serious problems to the operators. A central power plant located where a good supply of water and fuel is available can generate electrical energy and transmit it to the mines at less cost than any individual located at the mines and operating under less favorable conditions.

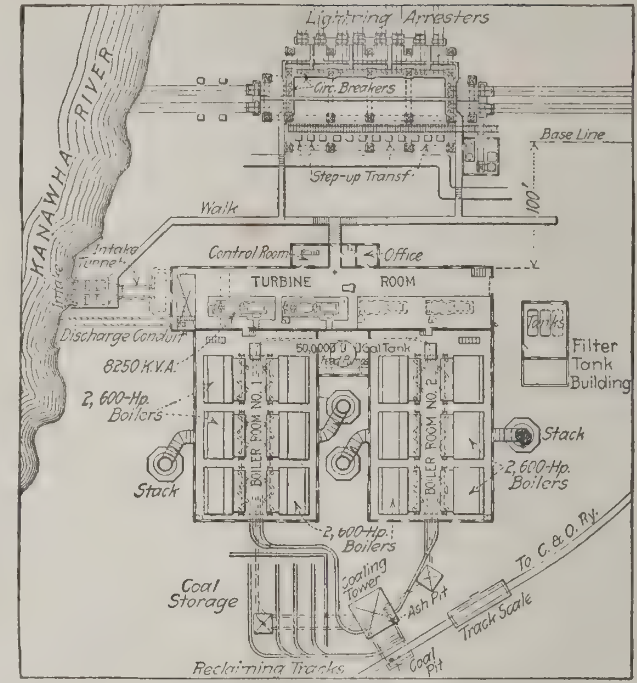


Fig. 3. Plan of Steam Station Virginia Power Co.

STEAM STATION BUILDING

As shown in the plan of Fig. 3 the steam station building consists of two boiler houses and turbine house forming a parallelogram with one side omitted, leaving an open court. The design called for two boiler houses to permit of short pipe runs to the turbines so as to make the structure designs more symetrical and to balance the boiler houses better with the room needed for turbines; to give more light and air on all sides; to make short and unitized boiler feed and blowoff lines and to facilitate central heating and pumping to all boiler units; and to make possible a second installation without any interference with operation. The present structures are ample in size to double the generating capacity of the first installation, including main generating units, boilers, stacks and auxiliaries.

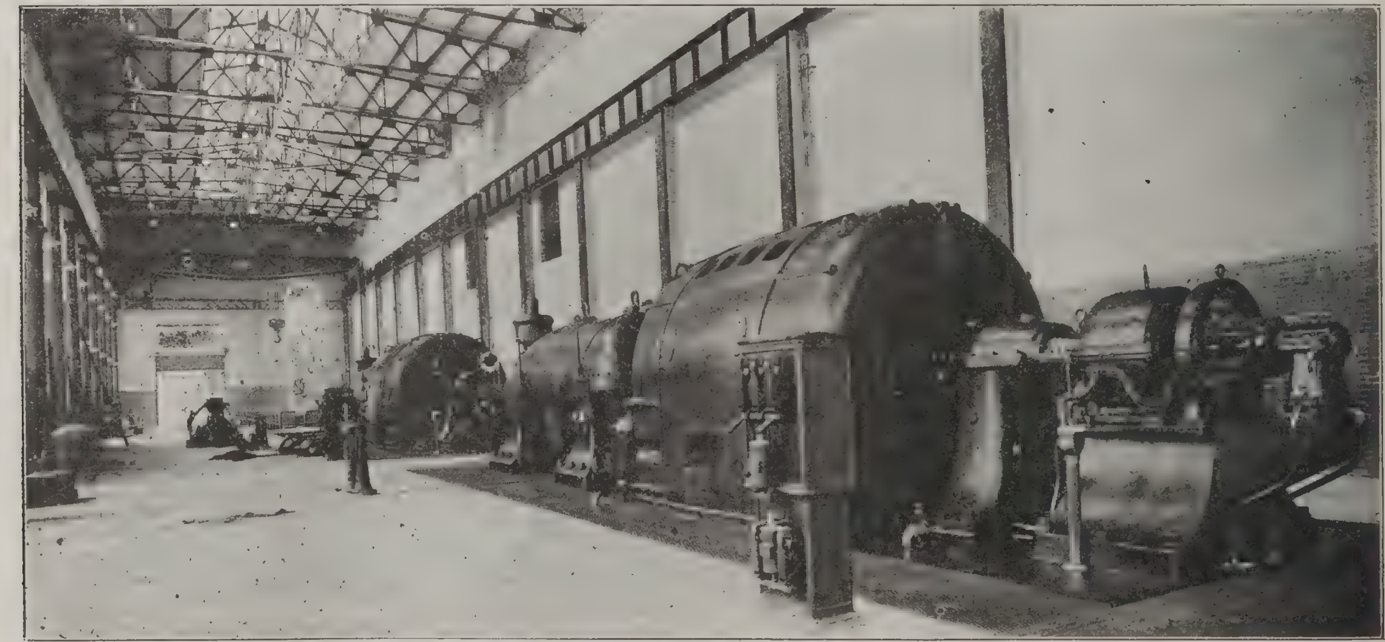


Fig. 2. View of Operating Floor in Station.

The substructure of the building is of concrete with the superstructure a self-supporting steel skeleton incased with brick walls plastered at the columns. Wall areas are broken by large windows with frames and sash of steel construction and sills and trim of white Georgia marble. Plainness of the walls is relieved by a deep brick cornice with parapet and concrete coping above. The entire main and monitor roofs are concrete slabs reinforced with ribbed metal, covered with four-ply bituminous roofing felt laid in the usual way, flashed and counterflashed at the parapets. Bolted slag is spread on top to prevent flowing of the compound.

All the buildings have a ground floor at grade and a operating floor at 14-ft. elevation above. This construction eliminates dark basements and affords natural light and air to all parts of the plant. The floor systems are steel frames carying reinforced slabs—all designed for a gross loading of 400 lbs. per sq. ft.

A lean-to opens off from the machine room and has a ground and a first floor. On the latter is the station control benchboard, a vestibule entrance for the power station, a chart room and a chief engineer's office. Below are the storage battery, power and lighting transformers and toilet rooms. Separate lavatories have been provided for the turbine-room and boiler-house forces. Both have porcelain plumbing and are finished with white Carara glass, of which seconds can be purchased cheaply and prove to be excellent for such industrial services.

THE BOILER PLANT.

The boiler plant is laid out in two parts and each is separately housed. The first installation provides for the full equipment of one boiler house namely, six batteries of vertical water-tube high-pressure boilers with superheaters. Each battery consists of two 600-horsepower boilers or 7,200-horsepower for the installation. Each boiler is equipped with automatic heavy-duty stokers in Dutch oven setting.

As shown in Fig. 3 the boiler house is divided into two sections, each section consisting of three batteries of boilers and stokers served by an independent stack of 11-ft., 4-in., inside diameter at the top by 262 ft. high; these are of steel plate, brick lined for the entire height. Natural draft alone is relied on. With the arrangement noted, the boilers and stokers can be forced to 200% rated capacity for peak loads. Further limitation of the boiler installation is not warranted, as it may be in more congested centers and where more pronounced peaks have to be carried for short times.

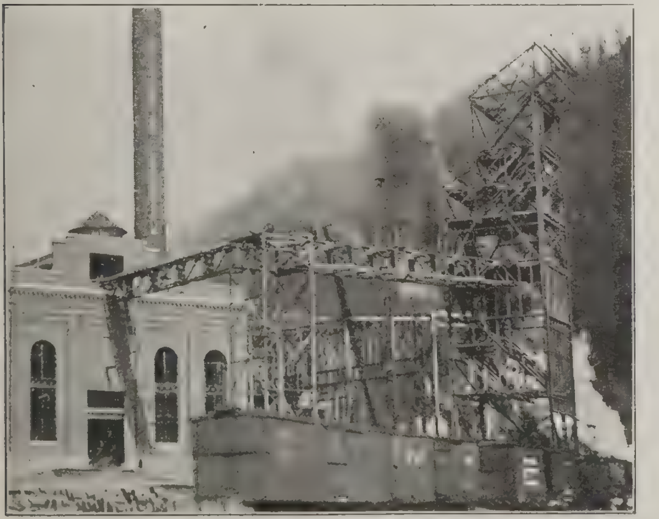


Fig. 4. Coal Handling Equipment.

Fig. 5. Motor and Steam Driven Pumps in Basement of Station.

Each boiler house is equipped with structural-steel, concrete lined, elevated coal bunkers, occupying the middle bay of the boiler house. Their capacity is 12 tons per lineal foot. The boiler house ground floor is arranged with commodious ash bunkers under the boilers with tracks in front of the bunkers. Ashes can be raked out into one-ton cars and delivered into an ash bunker at an outside track-hopper.

COAL HANDLING EQUIPMENT.

The coal storage plant consists (besides the boiler bunkers) of a structural steel tower containing coal-receiving hoppers, crushers and machinery to work with double skip hoists. The same plant handles outgoing ashes from the plant, there being separate ash hoppers. All these bins are concrete lined. There is first a track hopper for incoming coal which has a capacity for one full carload of 50 tons. The skips will be loaded by gravity from this. The tower will also have an operating platform at the proper elevation for the travel of the cable cars, which will deliver the crushed fuel from the coaling tower to the overhead boiler-room bunkers, as well as to the coal storage pile. The maximum capacity for hoisting, crushing and conveying of lump coal will be 150 tons per hour. The ashes come from the boiler-room ground floor in one-ton cars and are dumped into a trackbunker from which the coal skips are filled to lift the refuse to standard railway cars which are hauled over the same tracks on which coal is received.

This method of coal handling in connection with steam stations was adopted after an exhaustive study of such facilities made by the Engineer of the Virginian company some years ago in connection with another steam development at Youngstown, Ohio. The scheme is a modification of that perfected by the steel companies in handling material for blast furnaces. The installation cost is greater but the operation cost is small, due to low maintenance.

TURBINES AND GENERATORS.

The first installation of generating units consists of two 10,300 Kva. Parsons-type steam turbines each equipped

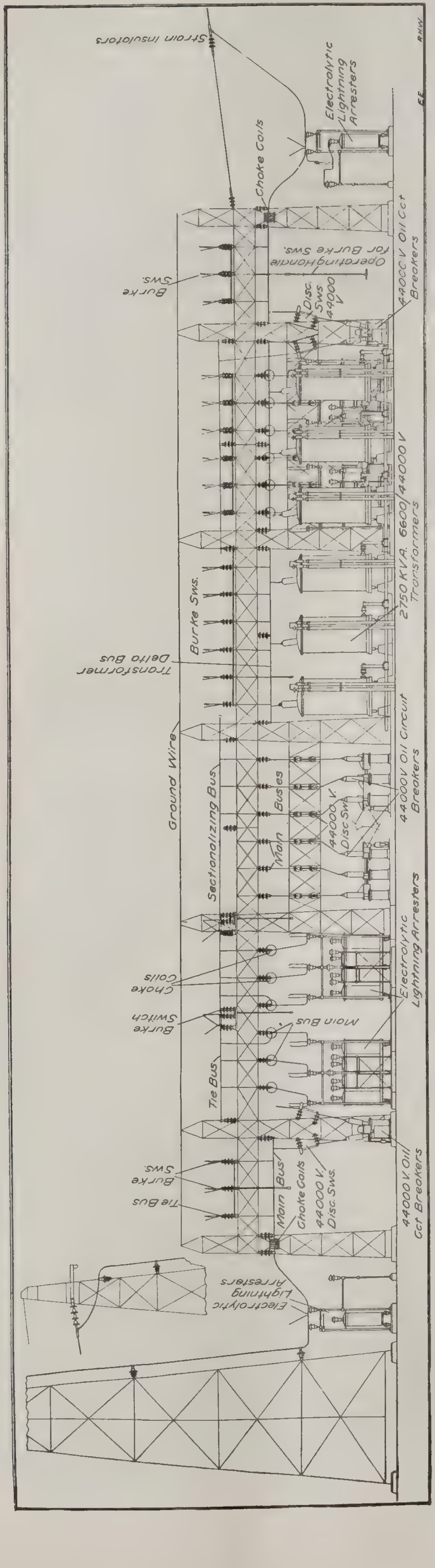


Fig. 6. Arrangement of Outdoor High Tension Switching Structure.

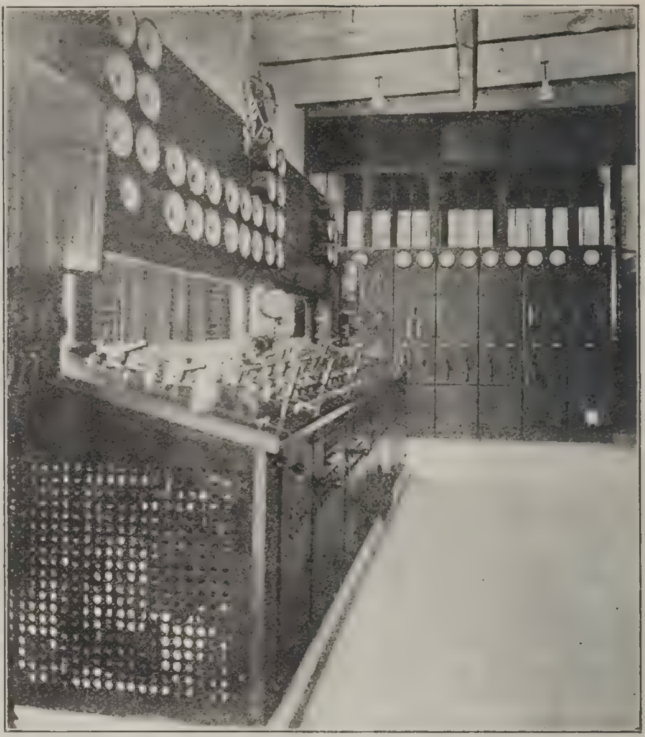


Fig. 7. Control Board at Steam Station.

with a 90-kw. direct connected exciter and an independent Le Blanc condenser. The latter are supported from the underside of the turbines, clear of the floor. The pumps of each are direct connected and driven by a 250-hp. reentry steam turbine. The plant is designed to operate at 180 lb. gage, 50 degree superheat, 28-in. vacuum. Intake and discharge of condensing water are through tunnels beneath the turbine room floor.

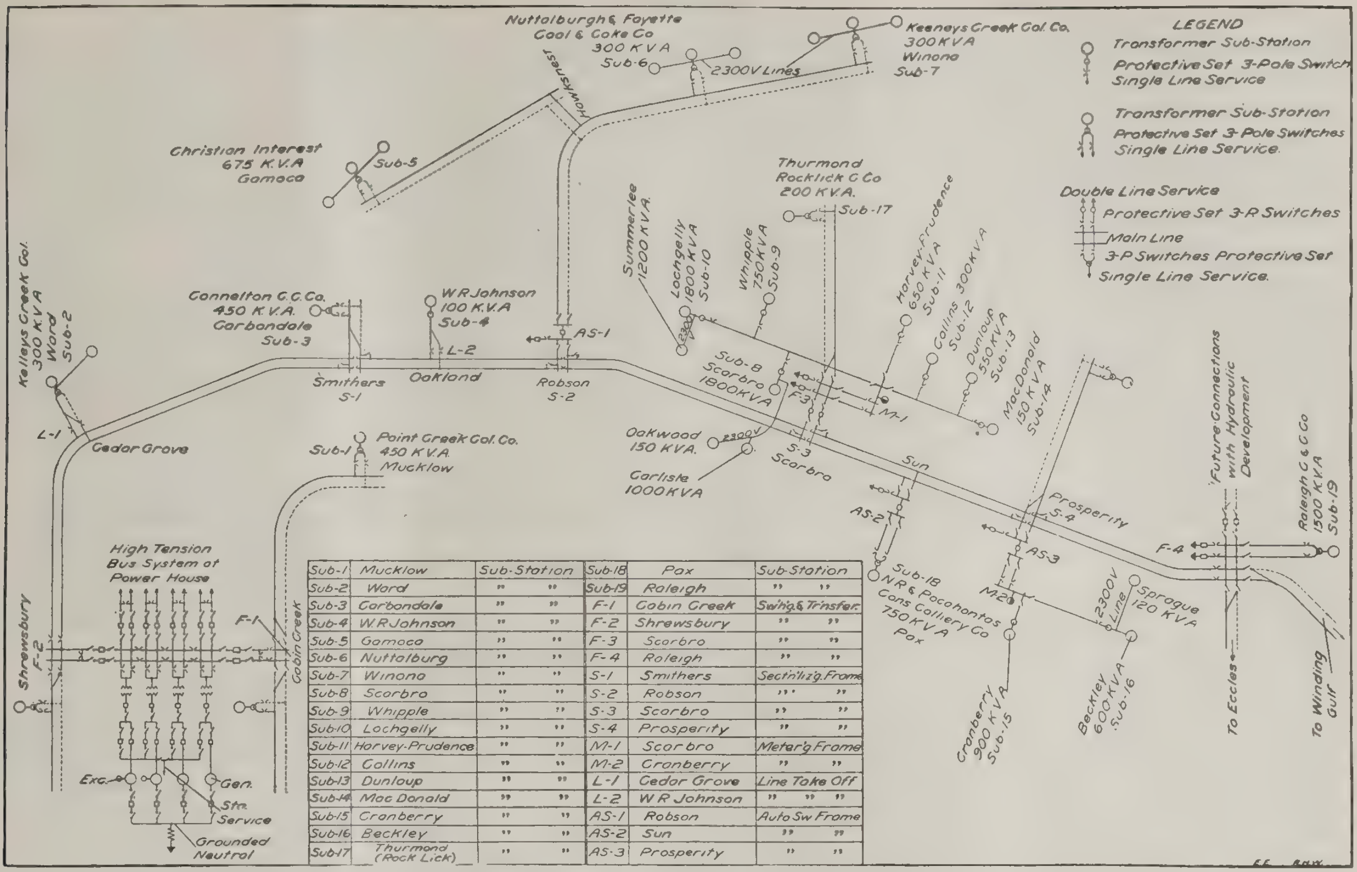
This station can be operated on the unit plan—a unit consisting of one prime mover with its boilers, and a generator with its step-up transformers and feeders with various interconnections posible. The main generators furnish three-phase current at 60 cycles 6600 volts at a speed of 1800 r.p.m.

In addition to the exciters direct connected to the main units, a 100-kw., turbine-driven direct-connected exciter is provided for emergency. When the final two main units are put in, they will not have the direct connected exciters as there is sufficient direct-current capacity in the three present exciters.

To supply the condenser tunnel, there are two 24-in. and one 18-in. turbine pumps with capacities of 17,000 and 8,500 gal. per min. The 24-in. turbine pumps are driven by 320-hp. induction motors and the smaller one by a 165-hp. steam turbine. Two 1000-gal. 6-in. centrifugal pumps serve the house lines and elevate the water to a 50,000-gallon storage tank, directly or through pressure filters, for boiler feed, transformer cooling and general service. One of these is driven by a 75-hp. induction motor and the other by a 65-hp. reentry steam turbine. There are two open feed-water heaters and purifiers, each capable of supplying 10,000 hp. of boilers. As feed pumps, two 400-gal. 200-lb. centrifugals are installed, each driven by a 96-hp. turbine.

STATION CONTROL.

The control of the station and the outgoing lines is centered in the switchboard room of the lean-to. The low-tension apparatus is on the ground floor with the high-tension equipment all out-of-doors. Both low and high


Nuttolburgh & Fayette Coal & Coke Co 300 KVA Sub-6
2300V Lines
Keeneys Creek Col. Co. 300 KVA Winona Sub-7
LEGEND
Transformer Sub-Station
Protective Set 3-Pole Switch Single Line Service
Transformer Sub-Station
Protective Set 3-Pole Switches Single Line Service
Double Line Service
Protective Set 3-P. Switches
Main Line
3-P Switches Protective Set
Single Line Service.
Christian Interest 675 K.V.A Gomoco
Sub-5
Hawksnest
Thurmond Rocklick C Co 200 KVA.
Sub-17
Summerlee 1200 KVA
Lochgelly 1800 KVA Sub-10
Whipple 750 KVA Sub-9
Harvey-Prudence 650 KVA Sub-11
Collins 300 KVA Sub-12
Dunloup 550 KVA Sub-13
MacDonald 150 KVA Sub-14
Kelleys Creek Col. 300 KVA Ward Sub-2
Connelton C.C.Co. 450 K.V.A. Carbondale Sub-3
W R Johnson 100 K.V.A Sub-4
L-2
AS-1
Smithers S-1
Oakland
Robson S-2
Sub-8 Scarbro 1800 KVA
F-3
M-1
L-1
Cedar Grove
Sub-1 Point Creek Col. Co. 450 K.V.A. Mucklow
Oakwood 150 KVA.
2300V
Carliste 1000 KVA
S-3 Scarbro
Sun
Prosperity S-4
AS-2
AS-3
Future Connections with Hydraulic Development
Raleigh C & C Co 1500 KVA Sub-19
F-4
High Tension Bus System of Power House
F-1
Cabin Creek
Shrewsbury F-2
Exc.
Gen.
Stn. Service
Grounded Neutral
Sub-18 N.R. & Pocahontas Cons Colliery Co 750 KVA Pax
M-2
2300V Line
Sprague 120 KVA
Cranberry 900 KVA Sub-15
Beckley 600 KVA Sub-16
To Eccles
To Winding Gulf

Sub-1	Mucklow	Sub-Station	Sub-18	Pax	Sub-Station
Sub-2	Ward	" "	Sub-19	Raleigh	" "
Sub-3	Carbondale	" "	F-1	Cabin Creek	Swh'g & Trnsfer.
Sub-4	W. R. Johnson	" "	F-2	Shrewsbury	" "
Sub-5	Gamoca	" "	F-3	Scarbro	" "
Sub-6	Nuttalburg	" "	F-4	Raleigh	" "
Sub-7	Winona	" "	S-1	Smithers	Sectn'liz'g. Frame
Sub-8	Scarbro	" "	S-2	Robson	" "
Sub-9	Whipple	" "	S-3	Scarbro	" "
Sub-10	Lochgelly	" "	S-4	Prosperity	" "
Sub-11	Harvey-Prudence	" "	M-1	Scarbro	Meter'g Frame
Sub-12	Collins	" "	M-2	Cranberry	" "
Sub-13	Dunloup	" "	L-1	Cedar Grove	Line Take Off
Sub-14	Mac Donald	" "	L-2	W R Johnson	" " "
Sub-15	Cranberry	" "	AS-1	Robson	Auto Sw Frame
Sub-16	Beckley	" "	AS-2	Sun	" "
Sub-17	Thurmond (Rock Lick)	" "	AS-3	Prosperity	" "

FIG. 8. LAYOUT OF TRANSMISSION LINES TO SUBSTATIONS AND COAL MINES.

tension apparatus is remote controlled. All the usual switches, busses, etc., are in full view for complete handling. Seven 2750-kva. oil insulated water-cooled single-phase transformers raise the generated voltage of 6600 to 44,000 for transmission. All the high tension apparatus, electrolytic lightning arresters, circuit-breakers, choke-coils, disconnecting switches and bus lines, are installed on the ground, alongside or upon the steel framework. So far as known, this is the first use of outdoor switching for a steam plant.

TRANSMISSION LINE.

The main transmission line is 46 miles long, running to Beckley, W. Va. It is sectionalized at four division points, so that in case of trouble the whole length of a circuit need not be put out of service. There are two independent circuits carried entirely on steel structures and square anchor towers each half mile, with semiflexible steel poles between. The three cables (No. 000 copper) of each circuit are vertically suspended and above each set is a galvanized-steel ground cable. The distribution branches are led off from both the main circuit lines by take-off frames, the branch conductors being 40% copper-clad steel.

Great difficulty was encountered in the building of the various lines due to the extreme rough country through which they run. In many instances even mules could not be brought within a half mile of the tower site and the material was snaked up the mountain side by means of snatch blocks and pulleys.

The voltage direct to the customers' transformers is 44,000. Coal mine operators are practically the only class of customer to be served and they call for transformer capacity of 100 to 2000 kw.. The customers are thus all comparatively large users of energy and analyzing their requirements is difficult. It has been found advisable to use out-door type large capacity transformer substations. These have rectangular frames of galvanized structural steel, the delta-connected transformers being carried be-

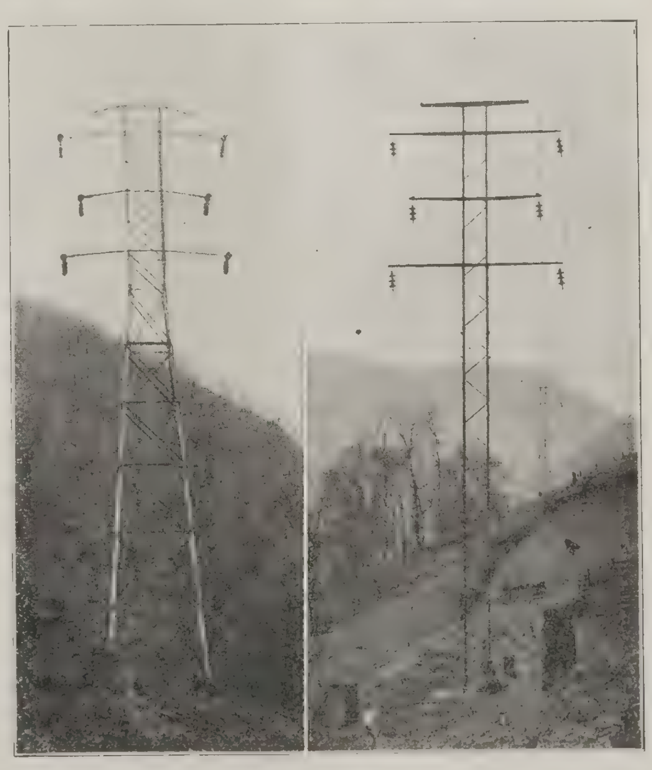


FIG. 9. TYPES OF STEEL TOWERS USED ON TRANSMISSION LINES.

neath the switch-gear, and in some cases the metering with its attendant current and potential transformers is housed in the frame. The low-voltage side of the transformers is carried directly to the individual substations owned by the customers themselves. Here the current is converted into direct or retained alternating—according as the work requires.

Houses will be built by the company for its employees. They will consist of a two story brick cottage for the chief operating engineer and six separate brick houses (four rooms and bath) of the bungalow type for the operators with families. A brick bunk house will take care of the remainder of the employees. All these houses will have electric lights; heat will be supplied by exhaust steam and a septic sewage disposal system will be provided.

The steam turbines and practically all the electrical apparatus was furnished by the Westinghouse companies, the boilers by the Babcock & Wilcox Co., and the hydraulic service pumps by the I. P. Morris and R. D. Wood companies. The steel transmission towers were furnished by the American Bridge Co., and the steel poles for subsidiary lines by Archbold-Brady Company.

C. O. Lenz, 61 Broadway, New York City, is chief engineer of the Virginian Power Company and has been responsible for design and construction. He has been represented in the field by H. G. Scott, general manager of the company and J. P. Harrington, resident engineer for construction.

A Comparison of Hydro-Electric & Steam Power.

BY REGINALD PELHAM BOLTON, CONSULTING ENGINEER, NEW YORK CITY.

An account of the activity in the development of water power sites in certain sections of the country by large and small central station interests, a general impression has been created that such developments make possible cheap power. In too many cases the fact that the value of water powers depends upon the equivalent cost of production by other sources of energy, is overlooked. Water power sites are usually located at points far remote from markets for electrical power and besides calling for the transformation of the energy represented in falling water into electrical horsepower, such energy must be transmitted, and distributed for general application and use. Its commercial or relative value therefore, as compared with electrical power generated by coal or any other fuel must be based upon the value of the distributed and utilized energy when generated at the point of consumption by the use of fuel. The importance and necessity of steam reserve stations operating in connection with hydro-electric plants and some data on performance of such plants was discussed by Mr. Bolton at a recent meeting of the American Society of Heating and Ventilating Engineers and an abstract of the discussion follows:

The statement that water power may not be as economical a source of energy as steam power, will doubtless constitute a disappointment and perhaps come as a sharp surprise to many persons, whose ideas on the subject have been developed merely by consideration of the apparently ready availability of energy in form of falling water. Official statements have been widely published as to the large quantities of power existing in water falls and rapids in this country. These statements always fail to convey the necessary information that the power is stated in terms of water horsepower, which is very different from the unit of generated energy.

The losses due to the process of generating electricity by water power are considerable: They consist in losses of head due to water shortage, loss in draft tubes, losses due to inefficiency of turbines, and varying heads and loads, dynamic and frictional losses in operating generators, losses due to transformation and transmission of electricity.

In the case of the large plant of the City of Seattle, tests were made, the result of which showed that of the dynamic force available in the water at the penstock, only 50 per cent. is represented by the transmitted energy in the form of electricity. Quoting from the annual report for 1911. "This study brought out the important fact that in determining the amount of power in a reservoir, the efficiency ordinarily assumed for the power units is much too high and misleading." While the combined efficiency of generator and wheel was found, in the case of the 5,000 kilowatt units to be 76.7 per cent., and in the case of the 1500 kw. units 69.9 per cent.; the all-day efficiency of the plant for 1911 was 56.7 per cent. Including current for excitation, the all-day efficiency was 55.7 per cent.

The losses are tabulated as follows:

Generating System—Per cent. of total energy at penstock lost:	
Penstocks	2.31
Water wheels	37.89
Generators	3.78
Exciters	1.26
Station lights and control	0.33
Loss of station output, of stock input	45.57
Transmission Systems	
Step-up	2.14
Transmission	0.72
Step-down	1.72
Loss of transmission system in per cent. of penstock	4.58
Total loss	50.15
Net energy delivered, of energy at penstock	=49.85

Back of these fundamental reductions in the value of water power, lie further burdens of cost of construction as compared with steam-power plants, which are increased by the cost of constructing, and expenses of operating, transmission lines. The statement has recently been made by Mr. Lucius B. Audrus, that, owing to the usual conditions prevailing around our water powers, it may be assumed that water power developments will cost about

$250 per kilowatt, the fixed charges on which, therefore, would amount to about $25·00 per year per kilowatt of maximum capacity. The cost of transmission systems will add from $100 per kilowatt upwards to this initial cost of development.

The Niagara transmission system of the Hydro-Electric Power Commission of Ontario has cost, up to October, 1913, $128 per kilowatt of maximum demand, and $60 additional per kilowatt, for transformation apparatus and transformer stations, making a total of $188 per kilowatt, the fixed charges on which are about $15 per kilowatt of maximum demand.

Carrying such initial burdens, hydro-created energy must meet, at the point of its distribution, competition established by any well-proportioned and economically operated steam system. Modern steam generating power plants have been constructed recently at a cost of $50 per kilowatt of installed capacity. The fixed charges are thus less than a third of the cost of the transmission system alone, such as that of the Ontario Government.

Mr. John C. Parker of the Rochester Railway & Light Company, states that a modern steam-generating station of 20,000 kilowatts capacity, with 10,000 kilowatts added for reserve, can generate energy at a cost of 0.5 of a cent per kilowatt hour, inclusive of interest, and a depreciation on its cost, and all operating expenditures.

The cost of hydro-electric energy in 1912 in several cities of New York state, were as follows:

Rome	1.140 cents per kw. hour.
Albany	0.907 cents per kw· hour
Syracuse	0.646 cents per kw. hour
Rochester	0.520 cents per kw. hour

The operating cost of steam-produced energy in the latter city was in 1912:

Fuel	0.170
Labor	0.126
Supplies	0.026
Repairs, etc.	0.022

The cost of the service of hydro-electric energy often looks attractive if the effect of purchasing energy by the annual horsepower rate is not fully appreciated. Appearance of cheapness is given to a service of this character when a consumer contracts for a supply of energy at a rate of say $25 per annual electric horsepower. Under the terms of such an arrangement, the consumer may use this horsepower at full capacity day and night, the whole year round. But under practical circumstances of industrial operation, it cannot be utilized for more than the usual hours of factory operation, or 3,000 out of 8,760 hours. Moreover, the conditions of all industrial operations are such that the full connected load cannot be utilized at all times, and the percentage of use of the

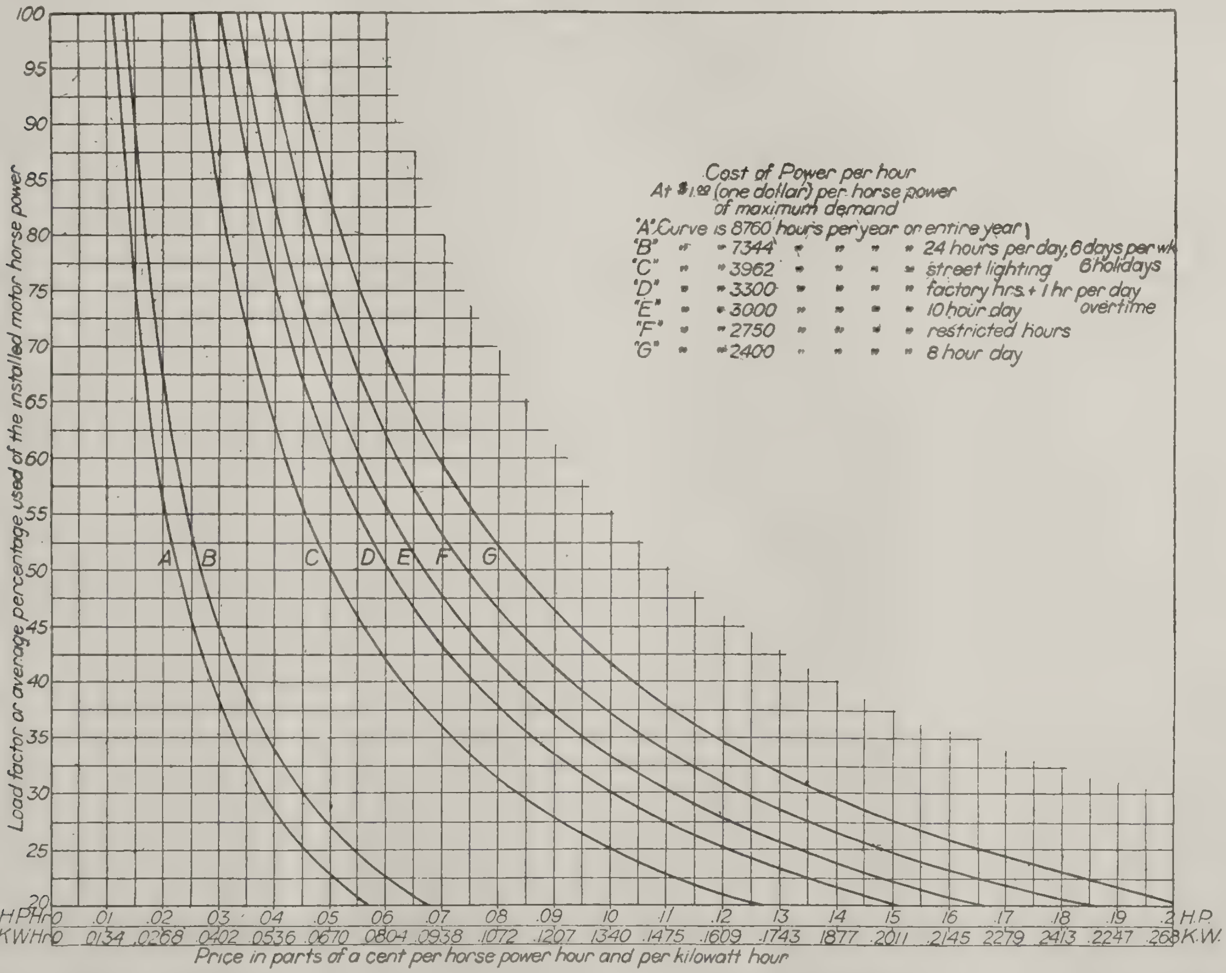


Fig. 1. Cost of Power for Various Hours of Use, Any Load Factor and on Basis of One Dollar Per Annual Horsepower of Maximum Demand.

Fig. 1 shows the unit price of an annual horsepower at various numbers of hours of use, and at any load factor on the basis of one dollar per annual horsepower. The price per horsepower hour, or per kilowatt hour, which is read upon the horizontal scales at the base of the diagram, should be multiplied by the number of dollars paid per annual horsepower. As an instance, the purchase of an annual horsepower at $25 used for 3,000 hours, on a 33 per cent average use or load factor, is equivalent to a price of 3 4/10 cents per kilowatt hour of energy actually used.

maximum or connected capacity will vary down to as low an average as 6 per cent· in certain industries.

Since the basis of comparison and competition is the utilized energy at the place where it is required, a steam plant developing energy as and when it is wanted, and meeting, without excessive losses, the fluctuations in demand, is at a considerable advantage, compared with a hydro-electric system in which the force is at all times available in full quantity and can only be varied by changing the number of units in operation. Still, it may appear to be, for those unacquainted with steam economies, a strange assertion that energy supplied from Niagara may not be as economical as steam-generated energy within a distance of twenty miles of the Falls.

Facts recently published by the Public Service Commission of the Second District, of the State of New York, in a recent case, No. 169, demonstrate that this is actually the case. A contract was proposed to be made for the purchase from one of the existing power installations at Niagara, of a minimum quantity of 46,000 electric horsepower, at a price of $12.50 per annual horsepower. The purchase of this energy involved an acquisition of franchises and rights of way, the cost of which ran into about a million dollars. In addition, a transmission line and transformer stations involved the expenditure of about one-half million dollars.

The following comparison of the elements of cost in this proposal, as compared with the generation of the same amount of distributable energy at the place of usage by steam power, shows that the latter is the more economical process of the two:

Cost of Niagara energy compared with steam:

Purchased amount—electric horsepower	46,000
Assumed sales, of connected load, e.h.p.	63,000
Equivalent in kilowatts, kw.	47,000
Assumed favorable load factor, per cent.	33
Output at point of delivery, kw. hrs.	137,000,000
Hydro-Electric:	
Purchase price at Niagara	$575,000
Operation to point of delivery	115,000
Interest and charges on transmission line......	55,000
Cost	$740,000
Steam:	
137,000,000 kw. hours at 0.5 cent	$685,000
Steam is cheaper by, per annum	55,000

Perhaps the most interesting feature in the development of hydro-electric processes has been the gradual dependence of such systems upon steam-power plants as reserve and security against breakdowns of their generating and transmission systems. When every precaution has been taken in connection with water-power development, or a transmission system, experience has shown that failure by ice or storm or flood must always be anticipated, and a necessary provision is required in the form of steam power reserve plants, the cost of which becomes an additional burden upon the hydro-electric development.

The author of "Hydro-Electric Practice" says, "A very good and learned friend of mine remarked that he 'could always find a hydro-electric plant by looking for a smokestack near a river," and Dr. Charles P. Steinmetz writes, "the possibility of a breakdown of a transmission line requires a steam reserve." When security and continuity of service are of value, steam power must be considered superior to water.

The most interesting demonstration of this fact has been very recently made in the report of the Commissioners of the Hydro-Electric System of the City of Toronto. This body, after only a few years of operation, has come to the conclusion that a million dollars, which is a twenty per cent. additional capital investment, must be spent upon the construction of a steam reserve plant in that city. Another striking illustration of the same process is found in the present construction of a steam generating station of 88,000 horsepower capacity by the Dominion Power & Transmission Company, of Hamilton, Ontario, only forty miles away from Niagara, and in a city served by its own hydro-electric system, as well as by that of the competing system of the Ontario Government.

There is one feature of cost in which hydro-electric developments have a distinct advantage over steam stations;—located as they are usually in unsettled districts, they are not burdened with the taxation which falls upon the plant located in a crowded community. It is a fact that in the great cities taxation is greater than the cost of coal, and is nearly twice what is paid for station labor. But even with this handicap, steam is often cheaper. It is the money required on investments which is the controlling element in the costs of energy, and these are always greater in the hydro than in the steam plant. Mr. Samuel Insull recently said, "It is not the price of coal, nor even the price of labor, it is the price of money that 'governs'."

Water powers have their use, limited to their own locality, and restricted in value elsewhere by competing forms of other natural forces. Their use has been somewhat widened by their adaptation to electric energy and its transmissible capabilities, but this very fact has brought the system into sharp conflict with its competitors on the ground occupied by the latter. As in the past, so at present, "coal is king," and its dethronement will not be effected by water power, but more likely by sun power. Neither development, however, has an incentive so long as supply, transportation, and methods of its use keep pace with demand. With oil, lignite, and peat as its alies, the use of fuels will increase far beyond the point where every water power on the continent combined could seriously affect the situation. The way of conservation does not lie in the path of water power developments, but in the direction in which we, as engineers, are specially engaged, the reduction of wastage, the promotion of economy, the spread of the habit of thrift and the improvement of the art of effective utilization of the fuels which nature has so abundantly placed at our command.

During the past five years domestic consumers have taken only about 63 to 67 per cent of the copper produced from mines within the United States, so it is evident that there must be a material curtailment of production while present conditions prevail. Considerable copper is of course consumed in munitions of war and for other military purposes, but the constructive arts of peace are far more favorable for the copper industry than the destructive art of war.

American producers have already greatly curtailed their production, and it seems almost certain that the output must be materially restricted for an indefinite period, dependent largely on the European conditions.

Selection, Care and Operation of Carbon Brushes.

BY E. H. MARTINDALE, E. E., MEMBER A. I. E· E.

Section 5. Characteristics of Brushes and Effect on Operation.

VERY little was formerly known by the operating engineer or electrician, regarding the characteristics of carbon brushes and the effects of these characteristics on the operation of electrical machines. During the past two or three years, however, carbon brush manufacturing companies have endeavored to educate the consumer along these lines by publishing all available data on the characteristics of their various grades of brushes. Some good has undoubtedly been accomplished by this work, but more good is left undone unless an effort is made to show the effects of the different characteristics on the operation of machines under different conditions.

At the begining of this year there were 13 companies in this country manufacturing brushes, 8 other companies were purchasing brushes in blocks or strips, cutting them up and selling them under their own names, and five foreign manufacturers had representatives in this country. These companies had 157 grades of brushes, the largest number manufactured by one company being 34. This company which is the largest carbon manufacturer in the world claims to be able to duplicate any carbon brush on the market, and to have several grades which are different from any others. If we accept this statement, we then have at least 34 different brushes, and some one grade will be a little better for any one machine than any of the 33 grades. It is then not surprising that it requires years of study and experience to select the best brush, after once seeing the machine in operation with any grade. The results obtained with one brush will often indicate what characteristics of the next set of brushes should be changed, but experience is necessary to know how much this characteristic should be increased or decreased.

The common physical characteristics of carbon brushes are, specific resistance, strength, hardness, apparent density, real density, and percentage and composition of the ash or impurities. The common operating characteristics are, co-efficient of friction, contact voltage drop, heat conductivity and abrasiveness. Of all these characteristics, the scope of this paper will permit a study of only specific resistance, hardness, co-efficient of friction, contact drop and ahrasiveness.

A word or two may however, be said regarding heat conductivity. There is no standard by which this characteristic has been measured, but as a general proposition it may be stated, that graphite has a higher heat conductivity than carbon. Therefore, if the temperature of a machine runs too high and if there is a large conducting surface on the brush holder rigging, a graphite brush (conducting the heat away more rapidly than the brush face) may reduce the temperature several degrees under that obtained with a carbon brush of otherwise similar characteristics.

Specific resistance is the resistance of an inch length of brush, one inch square and varies in carbon and graphite brushes from maximum of 0.0042 ohms to a minimum of 0.0003 ohms. Composition brushes of graphite and copper are made with resistance as low as 0.0000032 ohms. The accompanying curve of Fig· 1 shows the resistance of 119 carbon and graphite brushes on which data was available to the writer. From this curve it will be seen that 55 brushes or nearly 50%of the total number, have a resistance between 0.0011 ohms and 0.0014 ohms. The average resistance of the 119 grades is 0.00142 ohms.

The specific resistance of brushes has some effect on commutation though not as much as contact resistance which will be taken up later. A higher resistance brush reduces to some extent short circuit currents under the brush face, and to a still larger extent reduces any tendency to short circuit currents between different brush studs, which may arise from poor brush spacing. A low resistance brush will have a high carrying capacity but the reduction in resistance may increase the short circuit currents to such an extent that sparking will result and the ultimate heating be increased instead of decreased.

This brings up the question of carrying capacity of carbon brushes. It is very difficult for a brush manufacturer to make definite recommendation or guarantees of this value. Carrying capacity is influenced by many conditions such as short circuit currents under brushes and between studs, normal operating temperature of machine, speed of commutator, brush pressure, angle of operation of brush, ventilation, construction of brush holder, conditions effecting sparking, hardness of mica and a few others. Values given should be considered as relative only and even such is misleading as on some machines a normally low carrying capacity brush will carry a high current more successfully than a high carrying capacity brush, owing to other characteristics of the brushes.

An emphatic distinction must be made between hardness and abrasiveness. Hardness of carbon brushes can best be determined by use af a "scleroscope," an instrument commonly used in determination of the hardness of steel and other metals. Values of hardness in carbon brushes are relative and vary from 6 in the softest graphite brush to 79 in the hardest carbon brush. This grade with a hardness of 79 has no abrasive material in it and

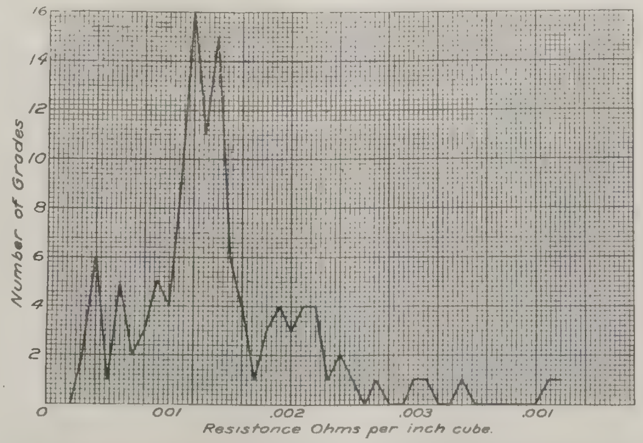


Fig. 1. Resistance of Carbon and Graphite Brushes.

will not wear a commutator even where it is slotted. One soft grade with a hardness of only 8 has some abrasive material and will cut and wear a commutator. A hard brush is an advantage on a commutator that tends to become rough as it will tend to even down the rough places. With a soft brush, the rough parts of the commutator wear the brush down rapidly. Other characteristics being the same, a hard brush will have a longer life than a soft brush.

Co-efficient of friction of carbon brushes was dealt with so thoroughly in the first of this series of articles appearing in the May issue of *Electrical Engineering,* that it is unnecessary to go into details here. To get proper commutating characteristics it may be necessary to use a brush with relatively high friction. It is, of course, imposible to get a low friction brush that has a scouring action as the scouring quality itself must produce a high friction.

A carbon or graphite brush may be placed in a special furnace and heated to a temperature that will burn out all the carbon. The residue is called ash and varies in weight from about one-half of one percent to thirty percent of the original weight of the brush. The composition of this ash largely determines the physical characteristics of the brush, particularly the specific resistance and the abrasive action. Silica, mica and carborundum are all abrasive materials which are found in the ash of carbon brushes.

Contact resistance of carbon brushes is the resistance between the commutator and the brushes when current is flowing. The contact resistance becomes less as the current density increases until glowing of the brush begins when the resistance rises suddenly due probably to an oxidation of the commutator.

Since the variation of resistance is nearly in inverse proportion to the current density, the current voltage drop which is the product of the resistance and current is nearly a constant value. In general the contact drop is less in a graphite brush than in a coke or lamp black brush. An exhaustive series of tests conducted by the writer on 13 grades of brushes at a pressure of 4 pounds per square inch, gave an average contact drop of 1.38 volts with a minimum of 0.86 volt and maximum of 2.16 volts. Each of these values is the sum of the drops under the positive and negative brushes.

Contact drop has a greater effect on commutation than the specific resistance of brushes. A brush with a relatively high contact drop will take care of a varying load much better than one with a low contact drop. Usually the heating is not any more and indeed is often less with a high contact drop brush because of the reduction of short circuit currents under the brush faces. It is hoped that this discussion of the effects of characteristics will assist the reader in the selection of carbon brushes.

Telephone Transmission as Effected by High Tension Power Lines.

BY E. S. MOORER.

EVER since high tension long distance transmission lines began to be constructed in this country, the problem of securing reliable and clear speech transmission has been a very difficult and expensive one. Only recently have devices and methods been worked out that furnish a means of coping with the situation when the telephone lines are strung on the high tension poles or towers, the most desirable arrangement. The effects of high tension power transmisison circuits on neighboring telephone circuits was the subject of a paper presented by Mr. Moorer of the engineering department of the Western Electric Company, at a recent convention of the Southeastern Section of the National Electric Light Association. An abstract of this paper is presented as follows:

Taking up the question of telephone lines exposed to high potential power lines there are two general questions to be considered. (1) The potential which will be found on the telephone line. (2) The means which are taken to counteract the effect of this potential and render the line usable.

There are two general sources of potential on lines of this character, one of which, actual physical contact between the wires, is an accidental condition and therefore relatively infrequent. The second source, induction, is one which is continually present. Induced potential is the result of two different phenomena, electro-magnetic and electrostatic induction. It is possible that both of these effects may be found in a single circuit but it will usually be found that one of the effects will predominate.

ELECTRO-MAGNETIC INDUCTION.

When an electric conductor parallels another conductor carrying a given current, there will be induced on the former a potential dependent upon the distance from, and the current carried by the latter. This electro-magnetic induction is the result of the cutting by the parallel conductor of the lines of force surrounding the disturbing conductor. This comes about from the fact that the passage of a current through any conductor sets up a magnetic field in its vicinity, this field consisting of circular lines of force perpendicular to the axis of the conductor and changing with each change of current in the conductor. This change in the field will cause the lines of force to cut across a paralleling conductor, thereby inducing an electro motive force in it. The greater the rate of change, that is, the frequency, the greater this electro-motive force in the second conductor; also, inasmuch as the strength of the field depends upon the current flowing in the energized conductor, the induced voltage in the neighboring conductor varies with the current. It also varies with the length of exposure and with the separation between the energized conductor and the neighboring wires.

In case there are several disturbing wires in which the currents are not in phase, the induced voltages from this source may partially neutralize each other. This neutralizing effect is the greater the larger the distance the parallel conductor is from the disturbing conductor as compared with the distance between disturbing conductors.

ELECTROSTATIC INDUCTION.

In the case of electrostatic induction, each of several wires can be considered as forming one plate of a condenser of which the earth is the other plate. The introduction of a potential with reference to the earth to one of the wires will cause an electrostatic charge to be induced upon each of the other wires with respect to earth. This induced charge changes according to changes in the inducing potential and varies directly with the potential of the disturbing wire. This induced potential also varies with the capacities of the wires to earth and to the disturbing wire, and therefore with the respective distances between the wires and between the wires and earth.

In the case of electrostatic induction also the presence of several disturbing wires whose currents are not in phase causes a partial neutralization of the induced potential, this effect being more nearly complete the greater the distance between the wires and disturbing wires, as compared with the distance between the disturbing wires. Inasmuch as electrostatic induction depends largely upon the capacities which the conductors have to each other and to ground and since every conductor has a capacity to all surrounding objects, the problem of determining analytically the potential which can be expected in any conductor is a very difficult one.

From the above it is seen that the induced voltage in a telephone line will depend upon the load and the frequency of the power line, and upon the length of exposure, in the case of electro-magnetic induction, and upon the voltage of the power line in the case of electrostatic induction.

Practically all transmission systems are three phase. There is, however, one other type of circuit that is especially troublesome to associated telephone circuits. This is the single phase alternating current railway. Trolley voltages up to 11,000 volts are in use and since the return is through the track and ground there is much smaller neutralization of the inductive effects. When the trolley voltage is high the induced voltage may be electrostatic but it has been found that in most cases the greater trouble has been experienced from electro-magnetic induction. The induced voltage depends to a large extent on the amount of current which leaves the track and returns through the earth, and this depends on the method of distribution employed in supplying current to trains. The question of operation of telephone circuits close to single phase railway circuits is so largely dependent on local conditions for each installation as to practically preclude the possibility of any general statements.

THREE-PHASE CIRCUITS.

In the case of three phase circuits there are in reality three separate sources of power of the same voltage and frequency but differing in phase of 120 degrees. These three sources of power are three windings on one generator. When these windings are connected to a three wire line the algebraic sum of the voltages between the wires is zero owing to the difference in phase. The generator voltage rarely exceeds 13,000 volts, step-up transformers being used to obtain the higher voltages. At the distributing end step-down transformers are used to obtain the voltage required by the load. The transformers may be either "delta" or Y connected and in the latter case the neutral point of the windings may or may not be grounded. If the neutral is grounded, this may be done directly or through a resistance.

Inasmuch as, assuming a balanced load, the algebraic sum of the three phase currents and voltages is zero, induction in adjacent circuits under this condition could be practically eliminated by placing the phase wires close together and making this distance between the phase wires small as compared with the distance from the telephone circuits, but even this condition would not eliminate inductive effects if the load is unbalanced. The high voltage of the phase wires however, requires a large separation and the location of the telephone line is often dependent upon its position with respect to the earth as well as with respect to the power wires. The result is that the inductive effects will be only partially neutralized and that an electromotive force will be induced on the telephone line. Another feature entering the consideration of the neutralization of inductive effects is the relative position of the power wires with respect to each other. There are three general types of construction employed by which the phase wires are located in a vertical plane, triangularly or in a horizontal plane. Inasmuch as the telephone line is almost always below the power line it will be seen that the greatest inductive effects will be experienced when the phase wires are spaced vertically since in this position the neutarlizing effects will be the least. In nearly all of the very high voltage systems the power wires are spaced vertically or approximately so.

The voltage waves from generators and transformers are usually distorted and do not vary uniformly according to the sine law. The distorted waves contain odd harmonics of the fundamental, the third and fifth harmonics usually predominating although higher harmonics may be encountered. These harmonics often cause high voltage peaks and these cause higher static effects in neighboring lines. Also since the harmonics are of higher frequency both the magnetic and static effects in neighboring lines will be increased.

In a three phase system the three line currents are one third of a cycle apart. The third harmonics have three times the frequency of the line current and are therefore in phase. These harmonics exist in the voltage between each wire and the neutral and in a Y connected system the three line wires act as a single phase circuit having a potential to the neutral equal to the voltage of the third harmonic. This is frequently the cause of static disturbances. When the neutrals are grounded there is produced a triple frequency current over the three wires with a ground return. Under this condition the electromagnetic induction in paralleling telephone lines is likely to be large.

Having considered the effects on neighboring telephone lines of high tension transmission lines, there will be taken up the consideration of the telephone lines themselves. There are two general types of telephone lines, one having a single line wire and using the ground as a return and the other using a full metallic circuit. Inasmuch as the telephone line carried on the same poles as a power line, is, through induction, at a considerable potential above the earth, the grounded telephone circuit is obviously out of the question since current would flow continuously through the instrument to ground making the line useless for speech transmission. In the case of a metallic line, the telephone wires will also be at a potential above the earth. However, if this potential is the same in each wire so that there is little or no current flow through the bridged apparatus the transmission qualities of the line will not be seriously affected, at least directly. When apparatus is installed to take care of these potentials to ground it will bring in substantial transmission losses.

PROTECTION FOR TELEPHONE LINES NEAR POWER LINES.

In private telephone lines exposed to high potentials it is the usual practice to insert between the line and the telephone instrument an insulating member which is intended to prevent conducting the high voltage to the instruments. In conjunction with this arrangement there are sometimes employed means for reducing the normal line voltage. Because of the fact that the telephone line is continually at a high voltage it will be readily seen that insulation of the line is of prime importance. Any leak to ground from one of the line wires will result in a flow of current from the opposite side of the line through the bridged apparatus, thus rendering the line inoperative. The practice is to employ on the telephone line high tension insulators having a dielectric strength much above the normal voltage on the line. Special care is taken in all other respects as regards line construction in order to eliminate as far as possible the chance for accidental contact between telephone and power circuits.

At each point on the telephone line where an instrument is located there is inserted between the line and the instrument a one to one transformer having a very high dielectric strength between windings. This serves to insulate the instrument from the high voltage line but at the same time permits the voice and signalling currents to pass over the line with however substantial losses in the telephone transmission. This transformer is generally placed in the drop wires and is mounted on a pole carrying the lead from the main line to the building. By this means only the wires connected to the secondary or low tension side of the transformer are brought into the building.

The transformer is protected against extreme line conditions by means of spark gap arresters and fuses. The arrester has a discharge voltage above the normal line voltage but sufficiently low to discharge on a voltage which would injure the transformer. Inserted between the arrester and the line are fuses of a comparatively high capacity, but which operate and open the drop wires in case of the flow of a current sufficient to injure the drop wires or arrester. Between the arrester and the transformer are inserted other fuses of lower capacity which open in the event of the passage of a current injurious to the transformer windings. On the secondary or low tension side of the transformer is placed another arrester of comparatively low discharge voltage. This is intended to take care of induced voltages on the secondary side of the transformer which would result from an unbalance on the primary side. Also on the secondary side of the transformer it is customary to place a switch by means of which the telephone set is normally disconnected leaving, however, the ringer connected in order that signals may be received.

Inside of the switch is located the telephone set and another protector having a still lower discharge voltage. The telephone set usually used consists of an ordinary magneto set having, however, all of the exposed metal parts grounded or insulated from the parts within the set. As a still further precaution most of the power companies provide a highly insulated platform upon which it is necessary to stand when using the telephone set.

One of the most important uses of these telephone lines is that of enabling the patrol man to quickly report any trouble which he may encounter in his trips over the high tension line. For this purpose telephone sets are located at frequent intervals along the line. The large number of these sets would cause a prohibitive load on the line provided they were all left permanently connected. To obviate this condition, at patrol stations a switch is placed on the line side of the transformer but inside of the arrester and by this means the transformer is normally disconnected from the line. This arrangement however introduces an added element of danger in that it is necessary to handle by means of a switch stick the switch which is connected to the exposed part of the line.

For patrol work the telephone set is often the out door type magneto set, having the case and metal parts grounded. Some of the larger companies however prefer to install small booths usually within the bases of the towers and to equip these booths with sets similar to those used at permanent stations. Where such booths are used it is customary to install high voltage disconnecting switches operated from inside the booth. The use of portable sets and means whereby connection to the line can be made at any point is of course extremely dangerous and is very rarely attempted.

TRANSPOSING TELEPHONE LINES.

One of the most important points in connection with lines of this character is that of transpositions. In any length of exposure one conductor will have induced on it a higher voltage than the other unless steps which are commercially impossible are taken to locate the telephone line in exact balance with respect to the power line. With one conductor at an appreciably higher voltage the line would, of course, be noisy. To eliminate this condition the telephone line is transposed at frequent intervals and the unbalancing inductive effects are neutralized. It is also important that the power line be transposed at intervals in order that the telephone line may not be exposed continuously to the inductive effect of one phase. It is necessary, however, that the respective transpositions in the telephone and power lines be so located with respect to each other that the effect of transposition will not be nullified. The transpositions of a telephone line will not, of course, reduce the voltage between the line and ground. The transposition of a power line tends to reduce the voltage between the telephone line and ground. The amount of this reduction is difficult to forecast with any degree of accuracy in a specific case.

At times there are installed devices intended to reduce the induced voltage of highly exposed telephone line. Such devices consist of some means of draining the induced current to earth. They are objectionable in that they are likely to give the users of the line a sense of security which might be fatal in case of the accidental destruction of the drainage device. The necessity for drainage is usually indicative of poor line construction or of insufficient transpositions in the power circuit and it is usually found more satisfactory to reduce induced potentials by remedying these conditions. The common form of drainage consists of a coil having two balanced windings so connected to the line that they are inductively in series across the line, but noninductively in parallel to earth. This readily allows the flow of induced current to earth but opposes the passage of current between the two sides of the line, thus reducing the shunt to talking and signalling currents. Another drainage method which has been proposed consists in surrounding the telephone line with grounded metallic conductors which tends to shield the line from static effects. The cost of this method is such, however, as to make its use prohibitive on long lines. A similar effect would be obtained by running the telephone conductors in a cable, but the usual long length of such lines would prohibit this method from a transmission standpoint even were it permissible from a cost standpoint.

In conclusion it can be stated that a large number of private telephone lines carried on the same poles as or closely adjacent to power lines are in operation. They are, of course, subject to interruptions, these interruptions coming in some cases when the line is most needed. Grounds on the transmission line cause a large increase in the induced voltage and noise on the telephone line. Surges due to switching operations, charging of electrolytic arresters, or other causes cause corresponding surges on the telephone line. The effects of such surges may be only momentary provided the proper form of arresters are used. To take care of emergencies many of the large power companies have arrangements with the local telephone companies over whose lines round-about connections can be obtained between certain important points on the power line. In spite of these limitations private telephone lines are considered indispensable by most of the operating power companies. As to the drawing of any conclusions which can be applied to any case, that is impossible. The peculiar conditions of each specific installation require that it be handled as a case apart. Even when equipped in the best manner known such lines are dangerous and cannot be considered in the same light as ordinary telephone practice.

Alternating Current Engineering.

BY WILLIAM R. BOWKER.

Section 19. Synchronizing Arrangements for Paralleling A. C. Generators.

When two or more alternating current generators are required in a station for light and power service, they are usually operated in parallel. In order to cause them to so operate, certain conditions must be fulfilled—that is, the machines must be synchronized. This means that before the machines are connected to the same busbars they must have the same voltage, same frequency, each operate at synchronous speed, and in phase or step—that is, the positive and negative alternations of each machine must occur at the same instant.

The connections for synchronizing two single-phase generators and the nature of a device known as a synchronizer are shown in Fig. 128. The alternator (A), which is already feeding the main busbar circuit, is connected thereto through a double-pole-single-throw switch (S_4). This alternator is likewise connected to the primary (P_1) coil of a small transformer (T_1), the synchronizer being connected as a shunt to the main circuit, the secondary coil being connected in series with a lamp and the secondary coil of another transformer (T_2), whose primary coil (P_2) is connected to a second alternator (B), which it is desired to switch into circuit or in parallel with alternator (A) on the busbars. The Emf. generated at any instant in the two secondary coils of the synchronizer, due to the mutual reaction of the magnetic circuit set up by the current flowing in the primary circuits or coils, may be acting either in unison or opposition. If in phase, the light given out by the lamp will be bright and steady, at which instant the machine should be switched in. If the mutual inductive action and reaction is in opposition or out of phase—that is, lagging or leading each other—the lamp will flicker, due to lack of unison in Emfs. generated in the transformer secondaries. To indicate the time of synchronism, a method much employed is to use lamps or voltmeters, or a combination of lamp and voltmeter methods. In the lamp method it is most common practice to connect the lamps so that they remain dark at synchronism. In Great Britain the circuits are so connected that the lamps burn at full brilliance and steady when synchronism is attained. The disadvantage of the "lamp dark" method is that if a lamp filament is broken it might result in the machines being paralleled when out of step.

In Fig. 129 connections are shown for two 2,000 volt, single-phase alternators with small transformers used to reduce the Emf. to 100 volts for the synchronizing lamps. A and B represent the alternators; (Sw) the double-pole-single-throw main switches; (E) and (F) the transformers; (L) the synchronizing lamps; and (P) the pilot lamps. To synchronize, bring the machine up to speed, assuming

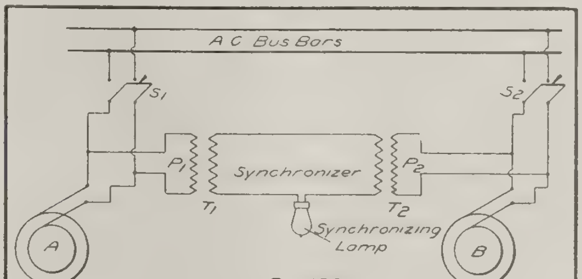


Fig. 128

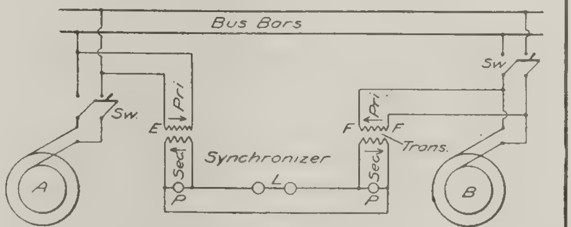


Fig. 129

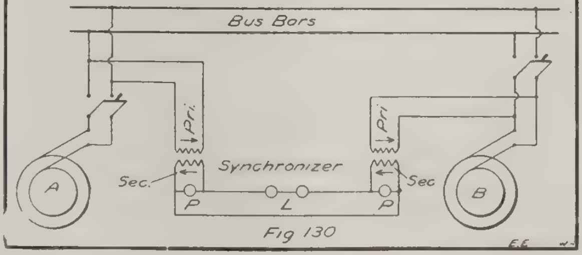


Fig 130

Fig. 128. Connections for Synchronizing Two Single-Phase Machines.

Fig. 129. Connections for Synchronizing Single-Phase Machines With Lamps Dark.

Fig. 130. Connections for Synchronizing Single-Phase Machines With Lamps Bright.

the alternator (A) is already delivering energy to the busbars; and when the synchronizing lamps are dark, synchronism is attained and the switches connecting the machines should be quickly closed.

In Fig. 130 is shown a synchronizing arrangement for single-phase generators where the lamps and transformers are connected to burn brightly at synchronism. Fig. 131 shows the synchronizing connections for the parallel running of two two-phase generators. It is necessary to synchronize both phases the first time the machines are parelleled; and after having once been "phased-out," synchronizing one phase is sufficient. In the diagram A and B are the two-phase generators; Sw the main circuit switches; E F G H the synchronizing transformers; and L L^1 the synchronizing lamps. To synchronize, close the switch of machine A; the lamps should flicker; then open A switch and close B switch to see if the transformers are rightly connected. If they are, open B switch and close A switch. Lamps L and L_1 should then glow brightly in unison. If one lamp is bright while the other is dark, the phases are not properly connected, and the lead wires of one phase on one machine should be reversed. Then test out the synchronizing apparatus as at first. If all the lamps glow in unison, the machines may be connected together without danger. The synchronizing apparatus may then be removed from one of the phases if desired.

In Fig. 132 a method is shown for connecting the synchronizing lamps and transformers for paralleling two three-phase generators. To synchronize, proceed as in the case of the two-phase machines. If the lights on both phases do not get bright and dark simultaneously when the machines are running at normal voltage, reverse two leads on one machine and try again. The right combination will readily be found. It is only necessary to "phase-out" two of the phases, for the third will be right. After the machines have once been paralleled, and the leads connected to the switchboard, synchronizing one phase is sufficient, as in the case of the two-phase machine.

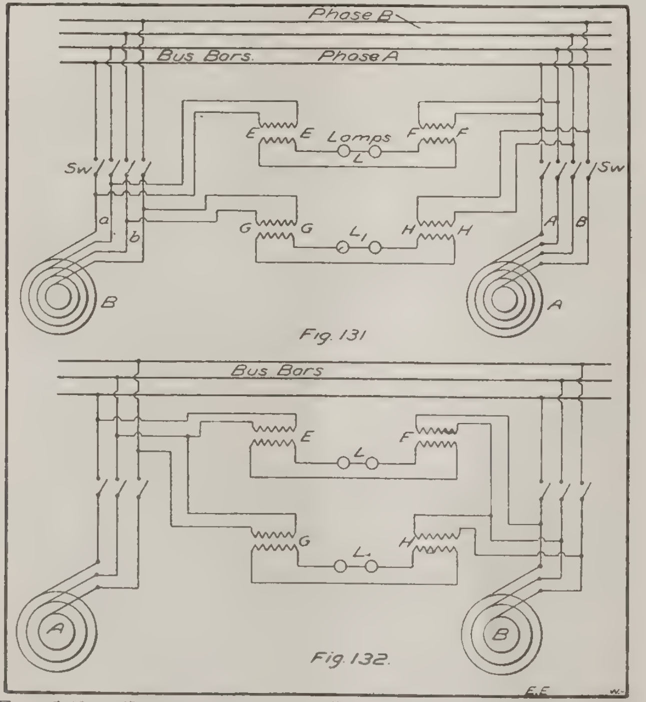


Fig. 131. Connections for Synchronizing Two-Phase Machines With Lamps. Fig. 132. Connections for Synchronizing Three-Phase Machines With Lamps.

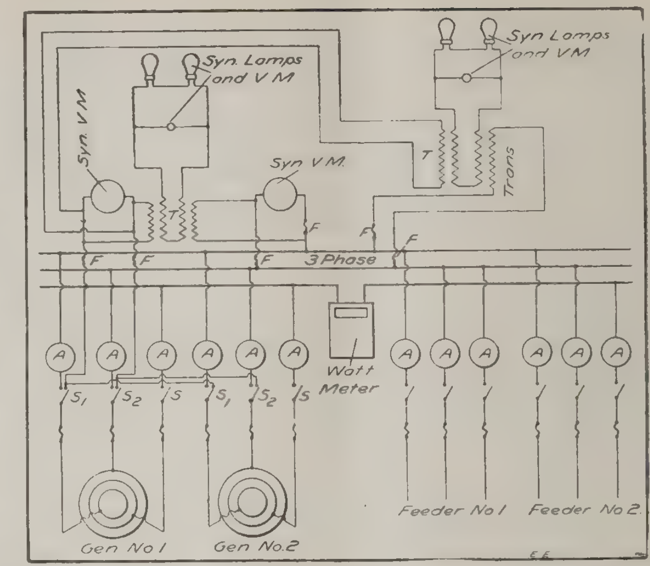


Fig. 133. Switchboard Connections for Three-Phase Synchronizing Circuit.

In Fig. 133 the switchboard connections are shown for a three-phase synchronizing circuit in which A indicates ammeters, F the fuses, S the switches, Syn. Vm. the synchronizing voltmeter, etc. The synchronizing lamps and voltmeters are shown; also the outlines of two three-phase generators Nos. 1 and 2 and two feeder circuits 1 and 2.

The general method of synchronizing alternators in practice has already been explained, it being also understood that after two and three-phase generators have once been paralleled it is then only necessary to synchronize one phase. As seen from the diagram in Fig. 133, the method consists in synchronizing by a combination of lamps and voltmeters. The lamps visibly show in a convenient manner the indicator of the synchronizer; but the voltmeter is a better and more reliable indicator than the lamps, for it shows the correct moment for closing the paralleling switch. The dead beat type of voltmeter is used in practice, as it instantly indicates any slight variation in pressure. In practice it may be considered that the lamp shows when the synchronism stage is being approached, and, finally, the voltmeter indicates the exact instant when synchronism occurs.

In the accompanying diagram it will be noticed that over switches S_1 and S_2 there are two pairs of contacts, the one located at the right of each pair of contacts being connected to the synchronizing circuit and those on the left are the main busbar connecting cable contacts. When a generator is to be switched in circuit or paralleled on to the busbars, the switches S_1 and S_2 are first placed on the synchronizing contacts. When the moment of synchronism is indicated by the lamps brightly glowing and the voltmeter reads steadily, the switch is quickly pushed over to the main circuit contact, at the same time breaking the synchronizing contacts and circuit. This is a very convenient and practical method of making the main contact and switching the generator in circuit with the busbars.

In large central stations the busbars are sometimes divided into sets so as to prevent the necessity of running the whole station in parallel when load conditions do not require it. In the divided busbar arrangement, in addition to the machine synchronizers for paralleling them to their respective busbar, there must be a busbar synchronizer which shows when the busbars themselves are in phase pre-

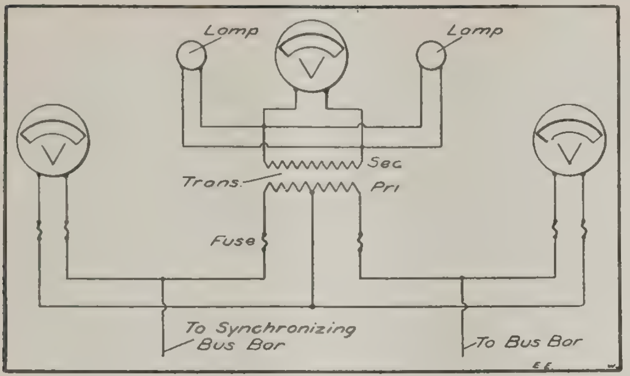


FIG. 134. CONNECTIONS FOR A LAMP AND VOLTMETER SYNCHRONIZER.

vious to coupling the divided busbars together for heavy loads.

The Lincoln synchronizer is one of the most ingenious and meritorious devices now used for synchronizing alternating current machines. This instrument provides a more perfect method of synchronizing than by lamps and voltmeters, either singly or in combination. The device is an indicating instrument constructed on the principle of a revolving field induction motor, consisting essentially of a small single-phase induction motor, in which the stator is excited from the station busbars and the rotor excited by divided-phase currents from the generator to be synchronized. The indicating needle or pointer is connected to the rotor and points to the zero marked on a dial when the machine and circuit are equal in frequency and also in phase, or when exact synchronism occurs. If the incoming generator is running too fast, the pointer moves to the right; and if too slow, revolves to the left. A complete revolution of the pointer indicates a gain or loss of one cycle in the frequency of the incoming generator as compared with the frequency of the busbars.

The switchboard connections for a Lincoln synchronizer are shown in Fig. 135, the potential transformers of which have grounded secondaries. The dial and casing that encloses the working mechanism and indicating pointer is illustrated by the circle, at the back of which are five terminal connections constituting the circuit arrangement as shown.

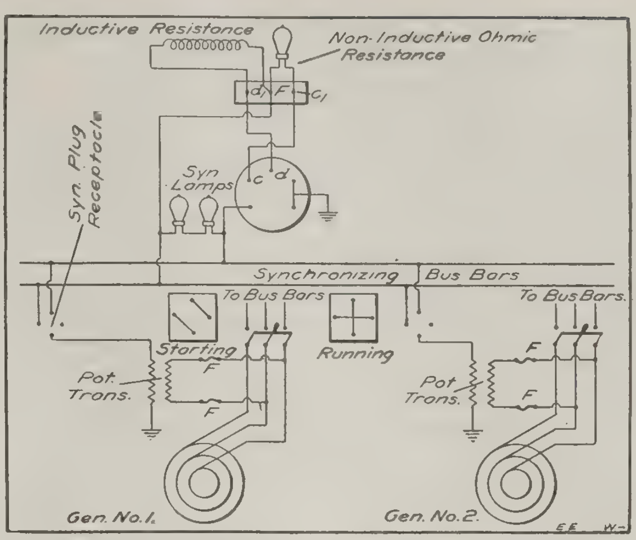


FIG. 135. CONNECTIONS FOR A LINCOLN SYNCHROSCOPE.

The effect of synchronism has a very important function in the practical, every-day working of alternating current stations and circuits, and it may be most usefully employed in adjusting the effects due to inductive loads, such as induction motors. When machines are in synchronism they run at exactly the same speed, but not necessarily generate the same Emf. Two machines may be running at the same synchronous speed, or in synchronism, and their waves of Emf. may rise and fall simultaneously, yet at the same time the value of the voltage may not be exactly the same.

A machine run as a synchronous motor has the effect of raising the power factor of a system and obviously its efficiency, by reason of its capacity or leading current effect if over-excited. By running a synchronous motor on the busbars of a station with the generator, and adjusting its field so as to be over-excited, it would generate a higher Emf. than that of the generator driving it, the effect of which is to gradually change the current from a slightly lagging to a slightly leading current, the amount of lead depending upon the degree of over-excitation. The capacity effect due to this leading current will tend to counteract any lagging due to inductive loads. This useful property can thus be practically employed to raise the power factor to approximately unity, or 100 per cent, by a correct adjustment of the excitation of the synchronous motor.

The next section of this article will discuss the operation of rotary converters.

A Practical Method for Testing Motors on Electric Trucks

BY RICHARD C. POWELL.

THE test to be described in what follows may not offer extreme accuracy in some cases, but it is very convenient when two similar motors are available, and will probably give more accurate results for testing electric truck motors than the usual improvised Prony brake. It has been found by the writer to be a very convenient way of getting the operating characteristics of automobile motors. The possible sources of error are due to two assumptions: First, that the generated e. m. f's. are equal with equal field currents and difference of 10 to 15% full load current in the armatures; second, that any two motors under test are identical and in particular, that the resistances of the armature circuits (including brushes and commutator) at any given speed are equal. It is known that the resistance of the armature cricuit increases somewhat with the speed.

The two motors for test should be direct connected as shown in Fig. 1. The armature of motor (A) is then connected in series with its own field and that of motor (B), the terminals of armature (B) being connected to a water rheostat. Three voltmeters and two ammeters are connected to give the volts at terminals of armature (A), of field (A), of armature (B), and the amperes in the two armature circuits.

Then let e = volts at field terminals (A); E_0 = volts at armature terminals (A); E_1 = volts at armature terminals (B); I_0 = amperes in armature (A); I_1 = amperes in armature (B); and R = resistance of armature circuit (A) or (B) at any given speed.

The power $E_0 I_0$ absorbed by armature (A) is used as follows: (1) heating armature A = $I_0^2 R$; (2) heating armature B = $I_1^2 R$; (3) Mechanical and iron losses in (A) or (B) = M; and (4) Output from B = $E_1 I_1$

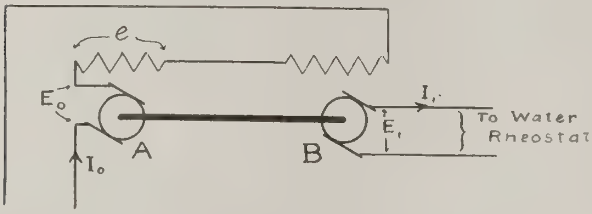


FIG. 1. CONNECTIONS FOR MOTORS UNDER TEST.

Or, the input and output is given by

$$E_0 I_0 = (1_0^2 + 1_1^2) R + 2M + E_1 I_1 \text{ — — — — } (1)$$

Since generated emf's are assumed equal,

$$E_1 + I_1 R = E_0 - I_0 R \text{ or } R = (E_0 - E_1 \div (I_0 + I_1) \text{ — — — — } (2)$$

The output of motor (A) in K. W. is then,

$$K = (E_0 I_0 - I_0^2 R - M) + 1000 \text{ — — — — } (3)$$

Substituting from (1) and (2) the values of M and R we obtain:

$$K = (E_0 I_1 + E_1 I_0) \div 2000$$

The horsepower, $HP = (E_0 I_0 + E_1 I_0) \div 1500$, and the torque in ft.-lbs. $T = 3.5 (E_0 I_1 + E_1 I_0) \div N$ where N = R. P. M.

The efficiency, $E = (1000 K) \div (E_0 + e) I_0 = (E_0 I_1 + E_1 I_0) \div 2I_0 (E_0 + e)$

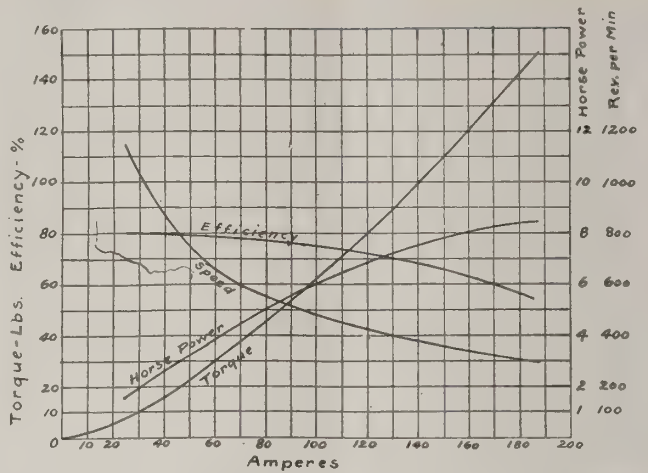


FIG. 2. PERFORMANCE DATA FOR A 60 VOLT, 60 AMPERE ELECTRIC TRUCK MOTOR.

The following results are from a test by this method on a 60 ampere, 60 volt motor, with fields in series.

RESULTS OF A TEST ON TRUCK MOTORS.

Applied Volts $E_0 + e$	Volts E_0	Amps. I_0	Volts E_1	Amps. I_1	R. P. M. N	Torque T	Horse Power H	Input K. W.	Effic. 7%
24.5	21.5	33.7	14.5	26.3	316	11.6	0.7	0.8	65.6
50	44	85	27.5	77.5	363	55.5	3.8	4.2	67.8
63	57	110	35.5	101	438	77.2	6.4	6.9	69.5
76	66	135	42.5	125	487	100.1	9.3	10.2	67.0
60	57.8	25	52	20	1150	7.5	1.6	1.5	80.0
60	53.4	57.5	46.5	51.2	640	29.5	3.6	3.4	79.4
60	51.2	95	44	90	505	60.9	5.8	5.7	76.3
60	50.4	130	35	121	420	88.7	7.1	7.8	68.3
60	48.4	155	31.5	148	370	114	8.0	9.3	64.5
60	45.0	187	23	180	298	150.5	8.3	11.2	55.5

This method can be used to obtain the electrical and mechanical losses in two similar electric trucks, by jacking up and driving one truck from the other, connecting the rear wheels with belts or rollers. All that would then be necessary would be to connect the driving motor to a source of power and the driven motor to a water rheostat.

Some Problems Met and Solved by an Electrical Trouble Man

BY J. A. HORTON.

Some Real and Imaginary Motor Troubles.

SINGLE-PHASE motors of the stationary type are not generally made to exceed capacities of 20 horsepower because the single-phase supply circuit is usually a lighting circuit and heavy currents incident to starting large motors disturb voltage conditions. Where polyphase circuits are available therefore, polyphase motors are, of course, used. In the case of a single-phase motor, unless it is of the commutator type, with series motor characteristics, it is customary either to use a standard polyphase motor in conjunction with a phase splitting starting box or a single phase motor provided with an auxiliary starting winding that is automatically cut out as soon as the motor acquires a speed approaching synchronism.

The writer was called in at one time to find out why a single-phase motor with a starting winding would not start. The motor was used to keep the seepage water out of a cellar and every time that the motor failed to start during the night, the operator had a cellar full of water awaiting him in the morning. Fig. 1 shows the connections as they were found. The regular stator winding in series with a float switch, was brought out at the top of the motor and included a single-phase single-throw switch, which was kept closed all the time. As a result, the starting winding was excited whenever the main stator winding was and it burned out, because starting windings are not designed for continuous use. The motor had originally included an automatic starting device consisting of a metal ring and a fiber ring installed alongside each other on the rotor shaft, as indicated in Fig. 2. One end of the starting winding was connected to the motor frame and the other end, to an insulated brush bearing on the grounded metal ring when the rotor was at rest. As soon as the machine took current, the rotor speed would rise practically to synchronism and simultaneously, the rotor would jerk over, due to the centralizing action of the field, thereby forcing the brush from the metal ring to the fiber one and interrupting the starting circuit. The rotor would then continue to operate single phase. The original starting device included a spring so disposed as to insure the rotor's being returned

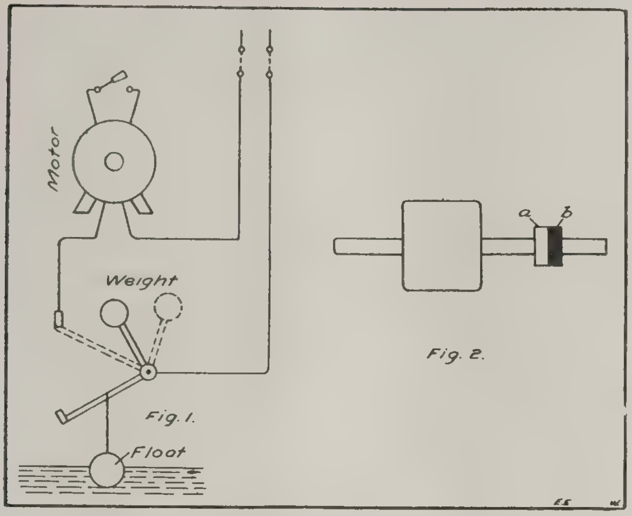


Fig. 1. Connections for Starting Motor as Found.

to the starting position whenever the current was interrupted. As such a spring was not available, the local electrician got the same result by tilting the motor a little so that the rotor tended to run over to the side that brought the metal ring in line with the brush.

A Good Use of Fly-Wheel Effects.

On account of fly-wheel effect, a given driven system has the disadvantage that more power is required to bring the system up to speed in a given time and unless the driving motor and its starting devices are proportioned to suit the conditions, they are apt to be dangerously overloaded during a prolonged starting period. Motor starting resistances often give trouble just on this account. On the other hand, however, assuming a liberal time allowance in starting and a finely graduated resistance of ample current carrying capacity, fly-wheel effect in a system has the advantage that once the system is up to speed, variable loads have less effect upon that speed and the motor is not subjected to the fluctuating electrical input that would obtain were neither fly-wheel nor fly-wheel effect present.

In a case in mind, an engineer became tired of standing by his circuit-breaker whenever the wood saw in the mill of a repair shop was being operated by a railway motor adapted to that service. As the motor was series wound, it would slow down until a belt slipped, but the breaker would often go out before this condition obtained. As there seemed to be no relief from any other source, the engineer conceived the idea of applying a fly-wheel to the motor armature and worked out his idea with an old gas engine fly-wheel taken from a scrap pile. A flanged extension from the fly-wheel hub was applied for use as a pulley. This device not only eliminated breaker blowing, but it increased the production of the saw and caused the motor to operate considerably cooler than it had ever operated before. This is a good illustration of how a fly-wheel may decrease the size of motor required without it.

Reversed Compensator Connection.

There is little likelihood of confusing the external connections of a compensator from the manner in which they are brought out and tagged. If for any reason the device must be taken apart, disconnected and reconnected however, an operator must either be familiar with the work or must mark his connections before disconnecting. In one case, an operator was not familiar with the work and the device was so badly burned by a short circuit following a lightning stroke that the original connections could not be identified for marking. The writer was called in to find out why the motor operated all right on the starting side of the compensator but would blow the fuses on throwing over to the running side. From the fact that the motor would come up practically to synchronism on the starting side, and that the first fuses blown had been in use for months, seemed to indicate that the trouble was not due to excessive connected load.

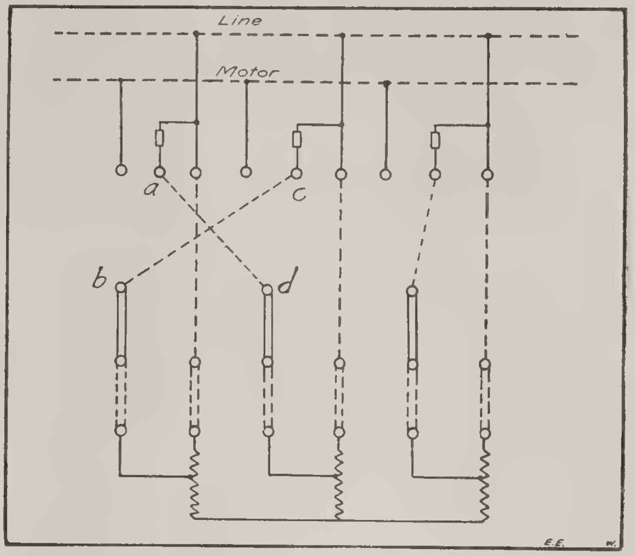


Fig. 2. Connections of Compensator That Gave Trouble.

On removing the belt and trying the compensator, the motor was heard to start, stop and spit and start again, and on looking at the motor it was found to be running in the wrong direction. The accompanying diagram indicates an internal interchange that caused the symptoms. Here (*a*) should connect to (*b*) and (*c*) to (*d*). Instead, (*a*) was connected to (*d*) and (*c*) connected to (*b*).

A Synchronizing Error.

The writer was once called in to find out why two alternating current generators caused their individual breakers to trip out every time an effort was made to throw them in parallel. An examination of the machines and of their connections showed everything to be apparently regular. They were loaded one at a time and the performance of each at all loads within rating was also perfectly normal. As the writer had never paralleled the machines, he inspected the synchronizing lamp connections to see whether the machine were intended to be thrown together when the lamps were dark or whether the switch was to be closed when the lamps were brightest. That is, whether the synchronizing connections were for synchronizing "light" or whether they were for synchronizing "dark." A glance showed that the connections were for synchronizing "dark," because it was evident that closing the switch would short-circuit the lamp and extinguish it. With the one machine on the load, the other was brought up to speed and thrown in when the lamp showed dark; they smoothly took up the duty together and everything was all right.

It seems that the operator was a new man who had always been accustomed to synchronizing "light" and it had never occurred to him that there was any other method of synchronizing. Accordingly he had used the "light" method on machines connected to synchronize "dark," with the result that each closing of the switch produced a short circuit through the two machines in series and with a total emf. twice that of either machine. Before synchronizing from lamp indications, it is important to inspect the connections to make sure for which synchronizing system they have been connected.

Papers Presented at Recent Convention of Southeastern Section N. E. L. A.

In the September issue of *Electrical Engineering,* the main points brought up in the discussions on papers presented at the Isle of Palms Convention of the South-Eastern Section of N. E. L. A. were reviewed. Space did not permit the presentation of the subject matter of the papers themselves, however, due to the special interest shown in the topics at the meeting, abstracts of these papers are given in what follows:

Irregular Thoughts on Regulation.

J. S. BLEECKER.

If it were not for the violent fluctuations which would result in rates, service and rate of return on investment, the regulation of public utilities, the same as other business, would ultimately be accomplished by the natural laws of trade, or fair competition in an open market, but it is almost heresy today to suggest such a method, and it is mentioned merely to be discarded and to show that it has not been overlooked. Neither the consumer, the operator nor the investor would favor this course of regulating public utilities, because all have tried it to a greater or less extent and displaced it for a much more effective means of accomplishing the desired results.

It is important that in selecting a means the purpose for which it was devised be not lost sight of, and it therefore becomes very desirable to ask ourselves what we are trying to do. The question of how should regulation be provided should possibly come after answering the two questions, "When should it be provided?" and "Where should it be provided?" but as it is almost universally acknowledged in this country at least that some regulation other than that of the natural laws of trade should be provided Mr. Bleecker answered the "how" of the problem by establishing a commission.

The author quoted Dr. E. B. Rosa, of the Bureau of Standards and arrived at the conclusion that the time element, or "when," played a very important part in the question of regulation, and that regulation should be applied, not only when the rate of return on investment is improper, but when the service is either below or above the standard. It should also be applied when the rate for service is wrong. It would seem from the geographical location of the various public service commissions in this country, and from the date lines of the news articles reporting their deliberations, that regulation is needful everywhere that a public service corporation operates, and that the rate itself is the easiest of the various questions involved, provided the other factors are given.

Feewer Voltage Regulations.

A. D. FISHEL.

The greatest voltage drop in distributing feeders naturally occurs at the time of the peak load. At this time a greater percentage of the load on the average central station feeder is composed of commercial lighting load. The resulting low voltage at the consumer's premises will therefore mean a considerable drop in consumption of energy by the incandescent lighting load. The decrease in energy consumption of the incandescent lamp at lower voltages, varies with the type of lamp, a 1% decrease in applied voltage below normal rated voltage giving a decrease of over 2% in watts consumption on carbon lamps, and over 1.6% on tungsten lamps; as the decrease in candle-power is at a still greater rate than the decrease in energy consumption, the consumer is neither beneted nor satisfied. While the amount of the loss in revenue will depend upon the voltage and size of the feeder, the percentage of carbon, metalized filament and mazda lamps in service, policy followed with respect to lamp renewals, the percentage of domestic heating and industrial motor load, etc., the investment in the automatic feeder regulator equipment will normally pay for itself in increased energy consumption, within two years, when conservatively estimated.

At light load periods, higher voltage than normal may be maintained without the voltage regulating control so that lamp renewals are increased disproportionately, since the life of incandescent lamps decreases at a rate greater than the increase in voltage. The direct effect of such increased cost of lamp renewals will fall upon either the central station, if free lamp renewals are being made, or otherwise upon the consumer. Constant voltage will, therefore, effect a direct saving in the first case and an indirect saving in the second, due to the satisfaction of consumers, with the decreased expense for renewals, and therefore a greater use of lamps for lighting, while the increased energy consumption does not balance the loss at periods of heavy load.

The use of automatic feeder regulators will often permit satisfactory service to be given with an existing feeder installation on which the load has grown to a point where excessive drop may exist at the periods of peak load, until such time as a readjustment of the feeders is desirable; furthermore, a material saving can often be made in the amount of copper used in the distributing feeders as the most economical size can be installed when automatic feeder regulators are used, whereas the voltage drop would usually determine the size of copper in a distributing feeder of fairly good size or length when feeder regulators are not used. Small feeders can often be economically combined when the question of voltage drop is eliminated, with resulting decrease as well, in number of service interruptions.

The single-phase feeder regulator has the widest application at the present time, because of its special desirability in installations wherein the commercial lighting load predominates, so that it is especially suitable for the ordinary city distributing feeder. On the other hand, there has been an increasing call for polyphase feeder regulators. This is due to the growth of high voltage transmission and distribution, as well as the fact that in many cases the power is now disposed of in "lump," and the large purchaser of what is called, in some places, "unrefined energy," has to provide his own voltage regulation.

The growth of high tension transmission has been especially marked in this Southeastern territory, and with its many advantages brings the problems of voltage regulation. This is due not only to the various high tension transmission systems in this territory employing transmission voltages of 60,000 volts and above, but is also due to the high voltage distribution that has recently grown very rapidly in the popular voltage classes of 6600, 11000, 13200 and 22000 volts.

Where a polyphase feeder regulator is used, the load must be fairly well balanced. With the polyphase regulator, the voltage fluctuations in one phase control the operation of the regulator, and the voltage in each phase is increased or decreased simultaneously by the same amount, so that singlephase regulators should be used unless the polyphase feeder is fairly well balanced with regard to voltage and current. Such balanced conditions will usually exist on large feeders and distributing lines which transmit power to stations or sub-stations where the system is subdivided into other feeders.

Single-phase regulators will usually be more desirable where a larger percentage of the load is commercial lighting; in such cases the usual range in standard feeder capacities will be from 50 to 600 Kva. per phase. Large feeders will normally employ polyphase regulators. On three-phase, four-wire feeders, single-phase regulators are usually employed because balanced load conditions are rarely obtained with this system. The single-phase regulator is operated between the neutral wire and each main. In the same way, single-phase regulators will normally be preferable for two-phase distributing feeders serving a mixed lighting and power load.

The best results from a feeder regulator installation can be obtained only when it is equipped for automatic operation. For this service the induction type of regulator has proved to be best adapted for both single and polyphase regulators. Various types were tried during the development stage of feeder regulators, of induction, floating coil, and step-by-step type regulating devices and service operation has proved that the induction type is best because of its simple construction, the smooth voltage regulation obtained, its relatively long life and low maintenance cost and the quick correction of relatively small voltage fluctuations.

Commercializing Electrical Advertising.

NORMAN B. HICKOX.

An abstract of Mr. Hickox's paper is found in the New Business Methods and Results section of this issue.

A New Method of Indicating and Recording River Stages.

MAC DOUGALD DEXTER.

A new type of pneumatic recording river gage has now been in operation for The Columbus Power Company since November, 1913, producing a continuous, accurate and reliable record of gage heights, and saving the trouble and expense of gage readers. A valuable feature of this gage is that the indicating or recording instrument can be placed at any point where most convenient for observation, and also, from the simplicity of the installation, the gaging point can be made at a place in the river where it would be very expensive or impracticable to install other means. This method of transmitting and indicating the fluctuating heights of water levels has been covered by letters patent, and the principle can be applied for gas pressure or steam pressure; for instance, in the distant transmission of pressure in a low pressure steam heating system.

Its principle is based on the simple law of pneumatics—that the pressure necessary to exclude the water from a tube with one end under the water is proportional to the head of water above the submerged end of the tube. To apply this for the purpose of river gaging, a small hollow wire, similar to that used in pressure gasoline lighting systems, is run from a fixed point in the river below low water mark to a suitable recording or indicating gage graduated in feet and tenths feet water column; and into this line, preferably near the river, another hollow wire is connected to supply a very small amount of comperssed air. The exit of the air is from the open end submerged in the river. In order to economize in the amount of air used, as well as to be assured of the fact that air is being supplied, a small sight feed receptacle is used; the air being caused to bubble through a liquid in a glass tube. The amount of air is regulated by a needle valve with a very small seat opening, and in view of the fact that any stored supply of compressed air is likely to fluctuate, a reducing governor or regulator is used to maintain a uniform pressure on the inlet of the needle valve. A fine copper gauze strainer serves to prevent stoppage in the needle valve orifice, and two small indicating pressure gages on either side of the reducing governor, or regulator, completes the installation. One of these gages indicates the pressure before the needle valve, which should be in excess of the head of water to be measured, and the other gage is merely to indicate the pressure in the air storage tank.

Some of the advantages of this pneumatic gaging system are that it is not affected by temperature changes; the ease of installation in what would be difficult, expensive or inaccessible places for other methods, and the fact that the point of air supply, or the recording gage can be distant from the point in the river to be measured. The end in the river being simply a pipe or tube placed in the water at any point or angle is certainly the simplest and cheapest installation of any gaging method, and can be easily placed so that it will not be dislodged by boats, driftwood, etc., and from the fact that from the lower end there is a continual supply of air, which makes it self-cleaning and free from stoppages of silt, etc.

RECENT DEVELOPMENTS IN INCANDESCENT LAMPS.

T. W. MOORE AND HENRY SCHROEDER.

The authors reviewed the developments in the art of lighting from 1800 to the present time. The early difficulties in manufacturing lamps experienced by Edison were mentioned and the improvements in life and voltage per candle power traced in each improvement and development in lamp making. This review led up to a discussion of tungsten lamps and the features of both the vacuum and gas filled types.

The authors also referred to the fact that on account of the manufacture of carbon lamps coming out at various voltages, lighting plants throughout the country some years ago were requested to use various voltages differing from the popular 110 volts, in order to utilize the entire product of the manufacturer, but at the present day with tungsten lamps this is no longer necessary nor desirable, and it would be much better from a manufacturing standpoint if everyone using Mazda lamps were to adjust their voltage to some one or two voltages, say 115 and 120. This perhaps may be impossible, but it is suggested that, with the dying out of the carbon and gem lamps, those customers below 115 volts gradually raise their voltage from time to time until their line voltage becomes 115, and those below 120 raise their voltage gradually from time to time to 120. By this means only two voltages of lamps need be manufactured and carried in stock. This ability to predetermine the voltage of a lamp also cuts out the necessity for photometering.

Improvements in lamps have permitted increasing the efficiency to 1 1-8 watt .per candle for the small sizes to .9 of a watt per candle for the larger sizes, as well as better maintenance of candle-power and better uniformity of life results. These improvements have been largely made by the introduction of chemicals in the bulb, which prevent blackening of the bulb or converting the black tungsten deposit on the bulb to a translucent white material, thereby bettering the maintenance of candle-power during the life of the lamp.

Important among the recent developments has been the announcement of a ½ watt per candle tungsten lamp. At the present time this efficiency can only be obtained with lamps taking a heavy current; such as 20 amperes. There has been developed a line of street series lamps, consuming 20 amperes, in 600 and 1,000-candle-power sizes. These lamps are for use on ordinary A. C. constant current series circuits; such as 6.6 and 7.5 amperes, by means of a current transformer for each individual lamp. 750 and 1,000-watt, 100-130 volt lamps have also been developed. The efficiency of these lamps at present is .60 and .55 of a watt per candle, respectively. They are not as efficient as the 20 ampere series lamps, as the filament being finer and longer is cooled to a greater extent by the gas in the lamp and, therefore, can not be run as high in efficiency. Series tungsten lamps of 60 candle-power and above for use direct on 5.5, 6.6 and 7.5 ampere series circuits have also been developed.

THE ELECTRIC VEHICLE.

A. L. DIXON AND F. N. CARLE.

The paper on this subject took up the conditions that have retarded the progress of electric vehicle exploitation by small central stations. These include the relatively slow perfection of the electric by the manufacturer; the unsatisfactory experience of some central stations with current consuming devices; and a wrong presentation of the electric to the central station manager by the electric vehicle manufacturer. In regard to the future of the electric in the South, the authors said:

"The next decade will see a greater industrial development in the South than in any other section of the American continent. The time is ripe for it and a great many factors, economic and otherwise, make an era of prosperity certain. You are handicapped by poor roads in some sections but many of your cities have road conditions most favorable for the operation of both types of electrics. Furthermore, you have in most sections an ample supply of cheap electricity, with more available. This insures individual motor drive from the day the factory turns its first wheel instead of in the second century as happened in New England. It is a great thing, from the standpoint of the electric vehicle, to have the local public accustomed to things electrical. You also have many enthusiastic young merchants who believe in having the best store and delivery equipment regardless of initial cost. Your million dollar office buildings in what we Manhattan Islanders call a small town are but indications of the spirit which does things, let old Precedent frown as she will. Other things being equal, a city of 50,000 in this new South should absorb more electrics in a year than a Northern city of 100,000 would in three years. You have your conservative element, it is true, but you have men who build $10,000,000 plants en toto with little more than their great faith in the future of the South to insure dividends. That is why the electric vehicle and the commercial electric especially, has a great future among you."

The remainder of the paper was devoted to arguments and statements intended to correct the impression that it is the central station rather than the electric that is being exploited and a presentation of believable facts. Suggestions were also made for securing vehicle business that were free from the taint of individual greed or business chicanery.

Thirty-third Convention American Electric Railway Association at Atlantic City.

The program for the 33d annual convention of the American Electric Railway Association to be held at Atlantic City October 12th to 16th, has been announced. At this time, the American Association proper and its four allied associations—engineering, accountants, claims and transportation and traffic—will all hold sessions. Over seventy-three committees are to report and papers are to be read on some important subjects. The speakers before the American Association include Hon. Frank W. Stevens, former chairman of the New York Second District, Public Service Commission; H. C. Donecker, assistant general manager, Public Service Railway Company, Newark, N. J.; Calvert Townley, chairman of the board of directors, Lackawanna and Wyoming Valley Rapid Transit Company; Harry A. Bullock, secretary, New York Municipal Railway Corporation and R. B. Steams, vice-president, the Milwaukee Electric Railway and Light Company.

Among the important reports to be made is one from the Committee on Public Relations, presenting a "Platform of Principles" covering what the Committee believes to be the fundamentals of a lasting and proper adjustment of relations between the railways and the public.

The Accountants' Association is to consider the new Classification of Accounts which was prepared by the

Interstate Commerce Commission in connection with one of the Committees of the Association, and will pass on a plan for an educational course for the accounting employes of electric railways. John R. Wildman, professor of accounting, New York University; H. S. Swift, treasurer, West Penn Traction Company; J. F. Fogarty, secretary, North American Company; A. T. Smith, assistant chief, division of valuation, Interstate Commerce Commission and Robert Sealey, North American Company, will deliver addresses. The engineering association has a very large number of important matters to come before it, including the reports of its standing committees.

To the Claims Association will be presented the report of its committee having in charge the formation of an accident prevention board, which it is intended will conduct a campaign for the prevention of accidents among the electric railways of the country.

Among the speakers before the Transportation and Traffic Association is N. W. Bolen, general superintendent, Public Service Railway Company, Newark, N. J., who will talk on the "Organization of a Transportation Department." This association will consider among other things a report of the committee dealing with the question of motor buses as auxiliary for electric railways.

The report of the joint committee on the "Joint Use of Poles," made up of representatives from the American Electric Railway Association, National Electric Light Association, the American Institute of Electrical Engineers and the American Telephone and Telegraph Company will be considered by the American Association. This committee has been at work for two years in the preparation of a form of agreements and specifications covering the joint use of poles and the adoption of its report, it is believed, will mean much in the clearing up of obstructions in the streets of the cities of the country.

New Business Methods and Results

Representing Interests of Central Stations, Electrical Jobbers, Dealers and Contractors.

Data on Ornamental Street Lighting.

The large number of ornamental street lighting systems that have been installed during the past two or three years have been made possible very largely by convincing local merchants that business streets were not properly lighted and that good lighting is a good advertisement for them. The results of this movement have been felt generally, for we now find that examples of good street lighting have called attention to the inadequate lighting of all city streets, causing many municipalities to rehabilitate entire street lighting systems in order to bring same up to an adequate standard.

A municipality owes its taxpayers proper attention to illumination of streets, not for the primary purpose of trade stimulation, but to promote safety and to facilitate traffic. Further, it should also be recognized that some streets need more light than others, the business sections being first in order, because the needs of traffic both of vehicles and pedestrians demand it.

The ornamental post system with tungsten lamps is very well suited to the needs of the business section, and for this reason has received the support of Boards of Trade, and Merchants' Associations. However, when it comes to general street illumination, the flaming arc, or the luminous arc mounted on ornamental poles, even in the business districts, with luminous arcs at the street corners supplemented by series tungstens in blocks of residence sections, have merits that demand recognition. The arc units should be hung high, 15 to 26 feet above the ground, not only to avoid a dazzling glare, but to give greater uniformity at a moderate expense. The variation of the horizontal component of the light rays should not vary more than 1 to 10 in business streets. Naturally, flaming arcs must be hung higher than luminous arcs because of their greater light flux. Uniform illumination either requires that they be hung high, or the use of more lamps, with excessive energy consumption. From 15 to 18 feet seems to be a suitable height for the metallic flame arc, and 25 to 28 feet for the flame arc.

The accompanying table gives data on a few selected average systems, using both ornamental tungsten clusters and arc lamps. It will be noted that the watts expended

DATA ON TYPICAL ORNAMENTAL STREET LIGHTING SYSTEMS.

Town	Spacing each side, feet	Lights per pole	Hours of burning	Per Pole		Per Foot			Revenue cts. Kwh.	Remarks
				Total cost	Rev. per year	Watts	Install. cost	Rev. cts. per mo.		
Savannah, Ga. ...	30	3-100 (Corners 5-100)	To 12 p. m.	$136.00	$36.00	12.3	$2.00	10.0	5.35	Conduit 3-wire system.
Atlanta, Ga.	70	5-100	To 12 p. m.	157.00	45.00	7.1	2.25	5.35		Conduit D. C. 2-wire system.
Tampa, Fla.	55	4-60 1-100	To 12 p. m.	84.00	45.00	6.2	1.53	6.8		
Jacksonville, Fla..	50 & 90	2 & 5 5-100 & 2-60	To 12 p. m. 1 all night	87.50	59.13 9.85					Part overhead and part underground.
Hamilton, Ont. ...	45	4-100 W.	To 11 p. m.	67.44	67.50	11.7	1.50	12.5	8.8	Underground, 110 volt system.
Duluth, Minn. ...	92	1-125 5-100	4 to 12 p. m. 1 all night	120.00	55.00	5.4	1.30	5.0	5.0	
Buffalo, N. Y. ...	100	5-60	4,000 hrs. per year.	50.00	37.50	3.0	.50	3.1	3.1	
Indianapolis	84	5-100	4 to 12 p. m. 1 all night	88.30	88.20	5.95	1.05	9.0	8.4	3-wire lead cable.
Lynn, Mass.	*130 *92	6.6 amp. Lum. Arc.			§70.00 82.40	*4.0 *5.6	2.00	*7.5 *4.5		Part of city lighting system.
Dallas, Tex.	72	6.6 amp. Lum. Arc.			45.00	6.0	2.00	5.4		
Missoula, Mont. ..	100	6.6 amp. Lum. Arc.				5.0				Combination lamp and trolley pole.
Milwaukee	50	Inverted Flame Arc.			90.00	9.6		15.0		

Unless otherwise noted installed complete with globes, lamps and wiring. § To midnight, $70.00; all night, $82.40.

* Main streets, 92, cross streets 130. Main streets 5.6, cross streets 4.0. Main streets 7.5, cross streets 4.5.

per foot varies from 3 to 12, with quite a large number of typical installations at 5 or 6. Flaming arcs run higher in current consumption per foot and also considerably higher in upkeep, due to increased trimming expense. Installation cost reaches a minimum at 50 cents per foot and a maximum at $5.00, with a good average at from $1.50 to $2.00 per foot.

Los Angeles probably takes the lead among American cities in ornamental street lighting, having now under contract over 28 miles, with about 3,000 poles. The earlier installations cost about $10,000 per mile, and the later ones from $7,000 to $8,000.

With an average spacing of 96 feet this gives a pole cost of $64, which is moderate. The upkeep, including current is $6,000 per mile, or $54.00 per pole per year.

Chicago has a very beautiful system on Michigan Boulevard along the lake front. This system was installed and is operated by the Board of Park Commissioners. There are 135 posts, each bearing six 100-watt lamps, 12-inch Alba globes. The poles are 19.5 feet high. Chicago now has under way an extensive rehabilitation of all street lighting, practically doubling the number of lamps, replacing the carbon arcs by flame arcs in the business districts and adding a large number of series tungstens. When these improvements are completed, Chicago will have the equivalent of over 27,000 arc lamps.

Milwaukee has recently installed 200 handsome bronze standards bearing inverted flaming arcs of 2,500 candlepower each.

Lynn, Mass., has installed magnetite lamps on ornamental posts. This system was purchased by the Board of Trade and presented to the city. The occasion was a red letter day for the town, being attended with music, speeches and general rejoicing. The system is being operated by the city as part of a municipal lighting system.

George H. Wygant, Commercial Agent, Tampa Electric Company Outlines Progress in Lighting.

About eighteen months ago the first white way street lighting system in Tampa was installed on eight blocks of the main street, (Franklin) 80 five-light ornamental posts being used with four 60 watt and one 100 watt lamps, the posts being spaced 55 feet apart. The system was installed by the property owners and paid for on a front footage basis, the city paying for street intersections on the same basis. Contracts were entered into with the understanding that after the first year the system would revert to the City, in consideration of which the City was to sign a five-year contract with the central station for the maintenance of the system at $45 per post per year.

The second section of the white way system, consisting of 52 five-light posts was installed on Lafayette street when a new $250,000 concrete bridge over the Hillsborough River was completed by the city. Decorative posts are installed along the street and on the bridge, 26 five-light posts of special concrete design being used on the bridge itself. Following this installation 42 more posts were installed on four blocks of the upper end of Franklin Street, making 122 posts on this street of the same design, all being installed on the same basis, namely $1.53 per front foot.

As a result of these installations, contracts have been recently closed to install 58 posts in the Latin section of Tampa known as "Ybor City." Two or three other sections are attractive prospects and have shown considerable interest. By the close of 1914 we expect to have 300 five-light posts of the same design installed throughout the city. In addition to this ornamental street lighting in the business section, 25 one-light standards with 100 watt lamps in 16 inch globes have been installed in a new residence section known as Seminole Heights.

In Tampa many of the streets have permanent awnings built over the sidewalk and special attention has been paid to lighting the sidewalks, using 150 watt lamps suspended from the awnings. When the ornamental street lighting system was installed, we were afraid that a large portion of this business would be discontinued as unnecessary, but as a matter of fact there has been a steady increase in this class of lighting, and we expect to displace a number of the 150 watt vacuum type lamps with the new 200 watt high efficiency, gas filled lamps that were recently introduced.

There has also been a marked tendency towards raising the standard of interior lighting since the advent of the tungsten lamp and now that the new high efficiency gas filled (type C) lamp is available in sizes ranging from 200 to 1000 watt capacity, the outlook is very bright. The 200, 300 and 400 watt sizes will be used extensively for interior lighting to increase the quality and candle power of present electrical installations and to displace gas arcs. The 750 and 1000 watt (Type C) lamps are proving very popular for lighting large factories, machine shops and the fronts of buildings such as theatres, etc.

The electric sign business has been keeping step with interior, sidewalk and street lighting. Our Company has installed a magnificent sign containing 1500 lamps, on its new office building which was opened last December, that has been the object of numerous favorable comments. There are a large number of attractive signs installed by the business houses in the city and a special sign campaign will be inaugurated soon when we expect to secure a number of orders.

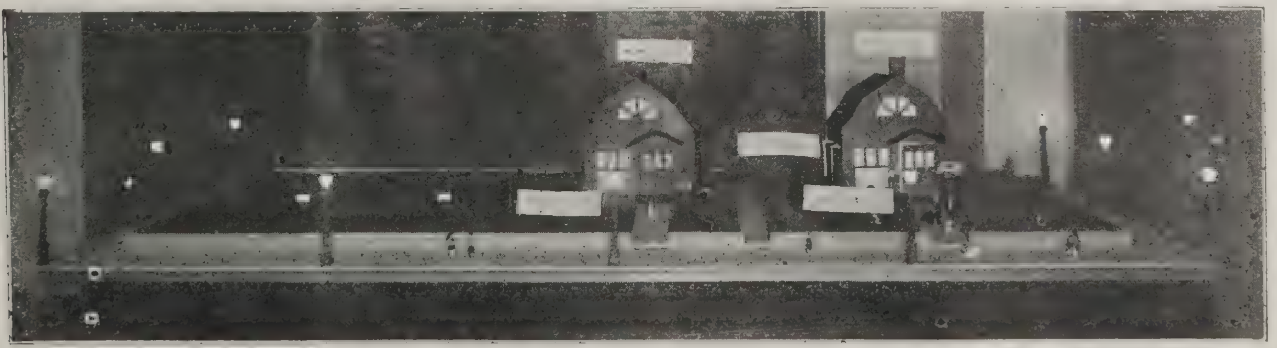


FIG. 1. WINDOW DISPLAY USED BY TAMPA ELECTRIC CO.

These different lines of activity seem to work hand in hand, all creating new interest in better lighting for all purposes.

The Edison Day Campaign of the Edison Lamp Works of the General Electric Company.

The success of a special campaign to stimulate the sale of tungsten lamps inaugurated by the Edison Lamp Company last year, has been responsible for elaborate plans for a similar campaign to be conducted during the next few months. This campaign will start on October 21st, which is to be known as "Edison Day," being advertised as such in some 70 trade journal, magazines and newspapers. Beginning with "Edison Day" central stations and electrical dealers will arrange special window displays similar to the one shown in Fig. 1, and thousand of circulars, letters and billboards will spread messages explaining the "why" of the Mazda lamp.

The co-operative publicity material now available for use by central stations and electrical dealers for the "Edison Day" campaign includes the following: (1) twenty-four sheet bill-posters displayed on spaces reserved throughout the United States by the Poster Advertising Association through its agents George Enos Troop, Inc. Special and thorough posting of any city has been made possible when desired. (2) Lithographed muslin outdoor posters for store fronts, delivery wagons, etc. (3) Small posterettes in the shape of stamps gummed on the back, for use on invoices, statements, backs of envelopes, and on parcels. These stamps display the statement "Edison Mazda—More Light for Less Money." (4) Four window display posters, one containing a chart of the cost of living and electric light, a second showing relative sizes of lamps and amount of electricity which $1.00 would buy at different periods from 1880 to 1914, a third the design of carton and lamps, and the fourth a large sized portrait of Thomas Edison suitable for framing. An exact replica of Edison's original incandescent lamp of 1879 is also available. (5) Blotters and post cards for distribution. (6) Street car cards and lantern slides. (7) Special lecture suitable for presentation at schools, church festivities and local clubs.

With good use made of these sales helps, plus the benefit of general publicity in all classes of magazines, a record should be established not only for October 21st, but for the entire 1914 lighting season.

The Lighting of Outdoor Spaces.

As indicated in the articles of the September (Annual Lighting) issue of Electrical Engineering, the lighting of outdoor spaces, such as tennis courts, athletic grounds, parade grounds, roof gardens, etc., is continually receiving more attention. The following examples of outdoor lighting are of interest: A tennis court at Kings Lawn, near Brooklyn is successfully lighted with 52, 100-watt tungsten lamps, hung 20 feet above the court. There are five rows of 8 each lengthwise of the court, and 6 along each of the ends. A tennis court at Newton Center, Mass., uses 24,, 250-watt tungstens, arranged 12 on each side, in holophane parabolic enameled steel reflectors.

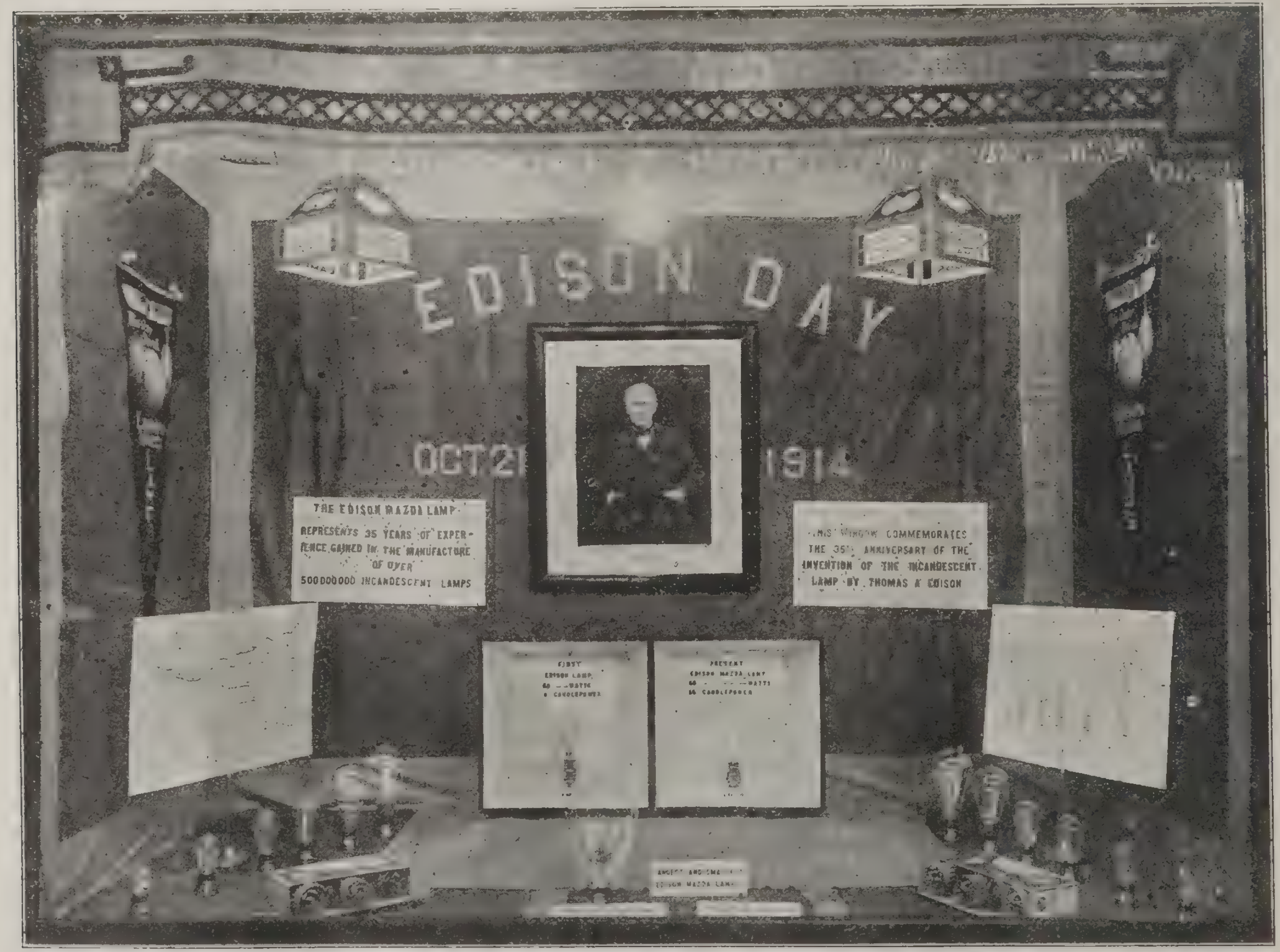

EDISON DAY
OCT 21 1914
THE EDISON MAZDA LAMP REPRESENTS 35 YEARS OF EXPERIENCE GAINED IN THE MANUFACTURE OF OVER 500000000 INCANDESCENT LAMPS
THIS WINDOW COMMEMORATES THE 35TH ANNIVERSARY OF THE INVENTION OF THE INCANDESCENT LAMP BY THOMAS A EDISON
FIRST EDISON LAMP
PRESENT EDISON MAZDA LAMP

Fig. 1. A Window Disflay for Edison Day.

Probably the most elaborate experiments lately undertaken have been at the Mohawk Golf Club, Schnectady, N. Y. These courts were first lighted with small units along the side. The results were fair, but there was some glare. Eight 400-watt lamps were used in angle reflectors, a total of 3,200 watts for the court. The lamps were 20 feet high. From this a change was made to 12, 250 watt lamps suspended 30 feet above the court in three special trough reflectors. This also gave fair results, but the intensity was too low for fast playing. The tennis ball when in position to be played is usually below the level of the eye and it requires a strong light from above to bring out the lights and shadows.

The next plan was to use four 1,000 watt (nitrogen filled) tungsten lamps, in a line 30 feet above the court and 28 feet apart. This gave a strong and uniform illumination. The wattage was 4,000, and the average foot-candles at 3 feet above the ground, 4.29, bringing the lumens per watt at 3.08, which was very good considering the total absence of reflection from surrounding objects. The superior efficiency of the non-vacuum gas filled tungsten lamp enabled as good illumination to be secured with 4,000 watts, as obtained in other courts with 6,000 watts. Furthermore, the construction used for the large units is simple and inexpensive.

The National Guard of Missouri, at its parade ground in St. Louis, uses 15, 250-watt lamps to illuminate the grounds which are about 500 feet square. The lights are hung in 3 rows of five each in a space 150 x 160 feet directly in front of the stables. This not only gives a good light over this space, but enables maneouvers to be carried on in any part of the parade grounds.

The roof gardens of the Hotel Van Ness, Burlington, Vt., are surrounded by a promenade 10 feet wide and 310 feet long. This is lighted with 27, 50-watt tungstens in 4-inch tubular opal globes, supported on one-inch pipe standards, which in turn form part of the pipe railing about the roof garden.

The railroad yards of the P. & L. E. R. R. at McKees Rocks near Pittsburgh, were formerly lighted by arc lamps on poles 25 or 30 feet high. Not proving satisfactory, the company has erected eight steel poles 100 feet high, four being located at each side of the tracks, which are 30 abreast at the widest point. The yards are about 2,000 feet long, with the tower spacing 500 feet. Each tower carries a quartz mercury lamp of 2,000 candlepower, consuming 726 watts. The height, diffusion and penetrating power of these lamps made a great improvement in the lighting of the yards. A. G. Rakestraw.

Suggestions for Promoting Sign Business.

A frank presentation of the drawbacks in promoting electric sign business and a few practical suggestions to overcome same was the subject of an interesting paper by Norman B. Hickox, of the Greenwood Advertising Company, Knoxville, Tenn., read before a recess meeting of the Southeastern Section of the N. E. L. A. An abstract of Mr. Hickox's remarks follows:

The central station must consider the electric sign solely from the commercial side, prizing it in exact proportion to its money-making capabilities. It is the business of the central station to know every electric sign on its lines, and in its city,—to know that each is properly hung and safely wired, and that future signs are of such quality as to require a minimum of attention. No central station, under proper management, will allow or encourage the use of inefficient apparatus for lighting, power, electrical heating, or for that matter, any apparatus constructed by inexpert, so-called ''electricians.'' Yet the ''tinsmith'' and the ''electrician'' attempt ridiculous installations of electrical sign displays, using the legitimate electric sign manufacturer's design and lay-out, and producing conditions which are absolutely dangerous, both from an electrical and mechanical standpoint.

To be successful in placing the greatest number of electric signs, and to promote a satisfactory campaign for such results, the central station must first be right on existing conditions. What are the characteristics of the signs now in your town? Are they dingy, decrepit, unwashed, unpainted, wholly or partially unlighted? Are they a credit to the owner, to the lighting company, to the municipality Are they unreasonably large and do they occupy an unreasonable amount of the public thoroughfare? Do they need freshening up, new lamps, adjustment of the flashers? Do they consist of every conceivable variety! Are they level, straight, safe, and will they pass, say, a reasonable electrical inspection? Do you really know just how many of them there are—the total consumption—the demand—the revenue? Do they burn on all kinds of rates, all kinds of ways and times—some one hour a night—others possibly every third or fourth night—and the rest when the owner happens to remember he has an electrical display actually connected up? What does your City Building Code say about the size of signs? Are any of the present signs violating the law? Or is the law an unreasonable one? Does it need repealing or amending before you feel that you can proceed with your campaign with any hope for reasonable results?

Most restrictive ordinances were placed on the statute books before the value of electricity and electric signs to the municipality was realized. Others were the outgrowth of continued abuse of what privileges existed allowing signs to project over the sidewalks and streets, the greedy ones placing their signs anywhere and everywhere, extending and enlarging them until, after an unhappy accident of some kind, heated and unfavorable public opinion placed prohibitive ordinances in force.

The author outlined several faulty methods for selling signs and pointed out that the most satisfactory sign-selling method, is adopted by those central stations of broad policy. These central stations handle the sign accounts for customers of good credit standing, spreading the cost of the sign, erection, and maintenance over a period of months, and recommending only the best makes of signs. This policy, once adopted, crystallizes into such form that the operating company gauges and picks what it considers to be the best organization to handle the situation of selling and manufacturing the signs, and co-operates with that particular manufacturer, with the interest of both at heart, and not calling on the manufacturer to do more than his share of the promotion and sales work

The cost of the sign from the manufacturer is taken as a basis, and to this figure is added the estimated amounts for freight, drayage, mechanical erection, wiring, low-voltage transformer (if used), first installation of lamps, estimated cost of renewals covering the contract period, a small charge for patroling, and interest covering the contract period. This total is then divided by the number of months that contract is to run, giving a fixed sum per month that customer will pay on the installation. Experience has proven that a figure of ten cents per lamp per month, on a basis of three years, or twelve and one-half cents per lamp per month, on a basis of two years, will more than cover the average installations, and that at the above figures, a profit will be shown at the end of any year, on that year's installations. The revenue desired per kilowatt hour is then fixed, which it might be stated in passing, averages very close to six cents in the entire United States, and the hours of lighting, or what is termed the lighting schedule, determined.

In our section, an eleven o'clock schedule seems to cover the average requirements, and it is estimated that such a schedule totals two thousand and eight burning hours per year, figuring from five-thirty P. M. until eleven P. M. each and every night. In round numbers, and using five watt lamps as a basis, with no allowance for flashing periods, eight and one-third cents per lamp per month will produce a revenue of ten cent per K. W. H.,—seven and one-half cents brings nine cents per K. W. H.,—six and two-thirds cents brings eight cents per K. W. H.,—five and three-quarter cents brings seven cents per K. W. H. and five cents brings six cents per K. W. H. It can, therefore, be readily determined that a rate of fifteen cents per lamp per month, on a three-year contract, will cover the installation complete, on an eleven o'clock schedule, and that the end of the period, the central station will have enjoyed a gross income of say, nine hundred and three dollars and sixty cents, representing the sale of fifteen thousand and sixty K. W. H. at six cents per K. W. H.

Concerning the Electrical Trade

News of Activity by Manufacturers, Jobbers, Dealers, Contractors and Engineers.

Henry A. Coles Becomes District Manager Atlanta Office Westinghouse Electric and Mfg. Co.

Seventeen years ago the Westinghouse Electric & Mfg. Co., opened a district office at Atlanta, in what is now known as the Equitable Building. Mr. J. R. Gordon was manager and Henry A. Coles a combination electrical engineer and salesman. The present organization comprises thirty men and is a co-ordinated unit of sales activity entirely responsible for the large business the company enjoys in the South. There has been but two changes in the management of the Atlanta office, one through death and one through promotion. Mr. J. R. Gordon, the first manager, died in 1911, and T. J. McGill succeeded him, being transferred from the Minneapolis office. Mr. McGill on Sept. 1st of this year was appointed district manager of the Chicago office and Henry A. Coles succeeds him as district manager at Atlanta.

Henry A. Coles was born in Albemarle County, Va., in 1870. He graduated from the University of Virginia in 1891 and went into central station operation for about three years, leaving this work to go with the Edison General Electric Co., at Schnectady, N. Y. In 1893 he resigned to go with Westinghouse Electric & Mfg. Co., and worked for three years in the old Garrison Alley shops at Pittsburgh, with Mr. Paul M. Lincoln, now president of the American Institute of Electrical Engineers, Chas. F. Scott, formerly consulting engineer for the company and now professor of electrical engineering at Yale and B. G. Lamme, present chief engineer of the company, an association with the company now a memory to comparatively a few of the 20,000 employes at the extensive present works located at East Pittsburg, Pa.

Henry A. Coles, District Manager Atlanta, Office Westinghouse Electric and Mfg. Co.

In the latter part of 1896 Mr. Coles was detailed on installation work at the Niagara Falls hydroelectric plant. This plant was the first water power plant to be installed of any size in the East and with the exception of the Telluride plant in Colorado of 100 Kw., single phase, not only the largest water power plant but the largest polyphase system in the United States. Two phase generators were installed with transmission at three phase by Scott connection of transformers, the first commercial application of this connection of transformers to be used in this country.

After the completion of this plant in the summer of 1897, Mr. Coles was transferred to Atlanta and, with Mr. Gordon, broke the first trails through the South for Westinghouse business. At this time, to use Mr. Cole's expression, "The territory of the Atlanta office included all states south of the Potomac River and from the Atlantic across to and including Texas. Mr. Cole's work as salesman included the covering of 10,000 miles of territory per month, for it must be remembered that in those days such systems and electrical demands as represented by the Southern Power Co., were not yet, and the electrical plants in such cities as Atlanta, Birmingham and New Orleans were of very ordinary size, operating for the most part belted types of engine driven generating units. The other plants and sources of electrical demand were to be located chiefly by the smoke from stacks that might be observed while riding in day coaches of not too comfortable railroad trains.

To contrast the conditions and demands for electrical equipment in those early days with the present, it is only necessary to remark that from the Atlanta office of the Westinghouse Electric & Mfg. Co., thirty men are required to cover the territory including the Carolinas, Georgia, Florida, Alabama, Mississippi, Louisiana and parts of Tennessee and Kentucky. The office organization is divided into three departments as follows: Railway and Lighting, with Mr. E. A. Thornwell manager; Industrial and Power, with Mr. J. H. Klinck, manager, and Detail and Supply, Mr. Thos. Fuller, manager.

With Mr. Cole's knowledge of the conditions and electrical needs of the South through his direct association with engineers and executives and with the co-operation of his efficient corps of assistants, it is certain that the Atlanta office has an opportuinty to even exceed its past record as a factor in promoting Southern development and profit by sales thereby.

With the exception of his interest in baseball, Mr. Cole's best known characteristic is his ambition to be first on the job when a contract is involved. As manager of the Lighting and Railway Department until his promotion, most central station men in the South have come to know him and this characteristic. About twelve years ago Mr. Coles married Miss Mary Norris, of Raleigh, N. C. They have one child. Mr. Cole is a full member of the American Institute of Electrical Engineers, a member of Capital City and Athletic Clubs of Atlanta, and a Jovian.

Questions and Answers from Readers

Readers are invited to make liberal use of this department for discussing questions, obtaining information, opinions or experiences from other readers. Discussions and criticisms on answers to questions are solicited. However, editors are not responsible for correctness of statements of opinion or fact in discussions. All published answers and discussions are paid for.

Calculating Horsepower of an Air Compressor.

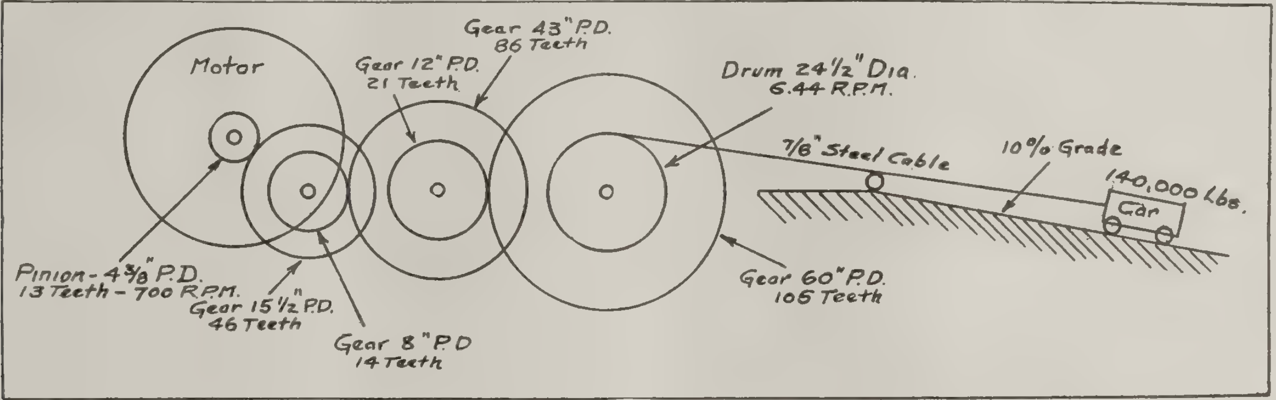
Editor Electrical Engineering:

(480) The writer has a 10x18x12 (duplex) air compressor running 45 rpm with a steam pressure of 125 lbs. The air pressure is 22 lbs. Another compressor 10x10x10 (single) operates at 60 rpm and 125 lbs. steam pressure. Air pressure is 45 lbs. Assuming an efficiency of 85% for each compressor, what will be the Hp. of each and the steam consumption per I Hp-hr? If sufficient data has not been given same can be furnished. G. T. B.

Power Demand of Electric Hoists.

Editor Electrical Engineering:

(481) Referring further to my question No. 469 in the August issue of *Electrical Engineering,* certain mistakes in gear sizes and other information should be corrected. The accompanying diagram gives the correct data and arrangement of hoist motor, gears and car. As stated in the previous question, the motor is 30 Hp., 220 volt, 3-phase, 25 cycle of slip ring design and runs at 700 rpm. If the motor is taking 75 amperes, what is the horsepower demand at the drum? F. C. DeWerse.



Layout of Electric Motor Hoist.

Why Connect Field Coils Ahead of Armature Coils in Street Railway Motors?

Editor Electrical Engineering:

(482) Referring to connections of street railway motors, what is meant by connecting field coils ahead of armature coils? What is the object of such construction? H. W. R.

Effect of High Frequency on Apparatus.

Editor Electrical Engineering:

(483) The writer has heard it said that high frequency low speed alternating current generators cannot operate in parallel and that high frequency induction motors must run at very high speeds to permit of a reasonable power factor of the system. Also that high frequency generators give trouble by heating at light loads. If these are facts please explain the reasons. J. C. B.

Method of Calculating Cost of Power as Generated by Steam Plant.

Editor Electrical Engineering:

(484) The writer would like to have some reader give in the question and answer columns, the details of the method necessary to calculate the cost of generating electrical power on a kw-hr basis by a steam plant. This method should show the different items envolved and how the different charges are calculated including fixed charges, operating expense, etc. Please work out the method using the following information and assuming any other that is necessary to complete any of the calculations.

The plant equipment consists of one 320 I. H. P. engine driving a 200 kw D. C. generator and one 120 I. H. P. engine driving a 75 kw. generator. The plant runs non-condensing. The coal cost is $3.00 per ton and water taken from a river. The maximum demand on the plant is 230 kw. and the average monthly consumption 62,700 kw.-hrs.

In computing the rate show how how it compares with the following central station schedule:

PRIMARY CHARGE.

1st. 10 kw demand	$3.50 per kw.
2nd. 40 kw demand	2.50 " "
All over 40 kw demand	2.00 " "

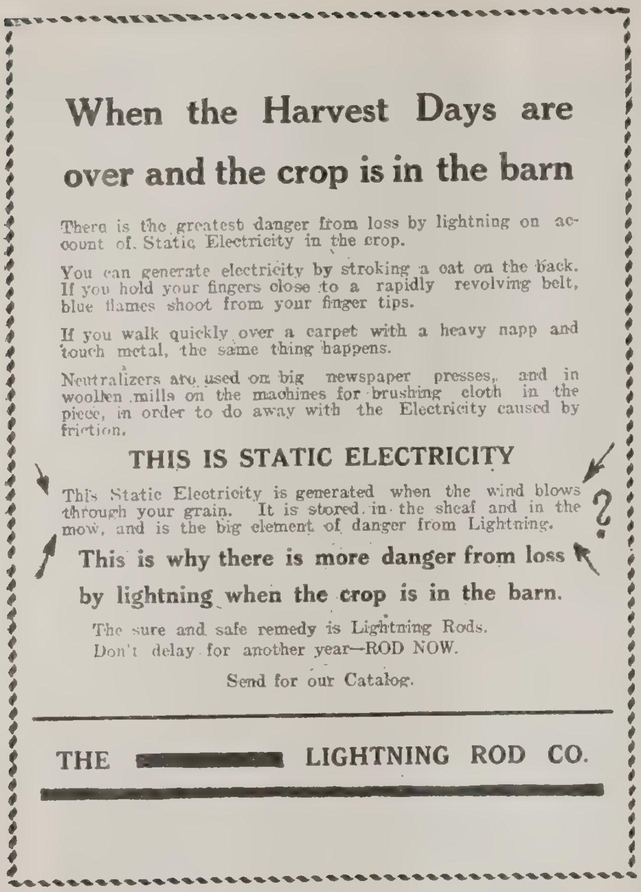
CURRENT CHANGE.

First	500 Kw. hours per month, 4.5 cents per Kw. hour.
Next	4,500 Kw. hours per month, 2.5 cents per Kw. hour.
Next	45,000 Kw. hours per month, 1.0 cents per Kw. hour.
Over	50,000 Kw. hours per month, 0.9 cents per Kw. hour.

If a rotary converter is installed and central station power used, is it practice for the customer to buy the machine? Is the customer expected to pay the converter losses? What size of converter would be required and what would the approximate losses be? G. T. B.

What is Function of Lightning Rods?

(485) The accompanying advertisement was clipped from a newspaper. I would like to see a discussion on the subject of lighting in the Question and Answer columns, explaining what takes place during an electrical storm, why



When the Harvest Days are over and the crop is in the barn

There is the greatest danger from loss by lightning on account of Static Electricity in the crop.

You can generate electricity by stroking a cat on the back. If you hold your fingers close to a rapidly revolving belt, blue flames shoot from your finger tips.

If you walk quickly over a carpet with a heavy napp and touch metal, the same thing happens.

Neutralizers are used on big newspaper presses, and in woollen mills on the machines for brushing cloth in the piece, in order to do away with the Electricity caused by friction.

THIS IS STATIC ELECTRICITY

This Static Electricity is generated when the wind blows through your grain. It is stored in the sheaf and in the mow, and is the big element of danger from Lightning.

This is why there is more danger from loss by lightning when the crop is in the barn.

The sure and safe remedy is Lightning Rods.
Don't delay for another year—ROD NOW.

Send for our Catalog.

THE [redacted] LIGHTNING ROD CO.

An Ad. Used to Sell Lightning Rods.

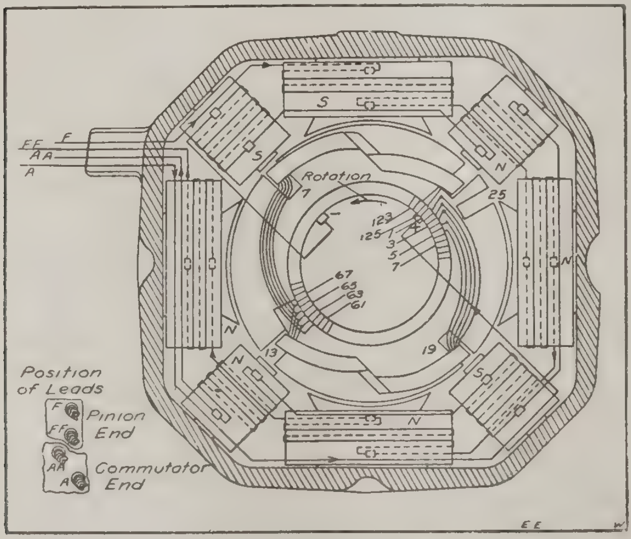
lightning seldom strikes twice in the same place, what conditions cause lightning strikes in any case and how lightning rods are a protection to buildings. Such a discussion will clear up a lot of doubts among many of us engaged in practical electrical work and help to explain some difficult questions so often asked. The arrows marking one of the paragraphs of the advertisement call attention to a statement that needs comment.
E. W. Hall.

Armature Winding for Railway Motor, Ans. Ques. No. 449.

Editor Electrical Engineering:

In reply to a request from B. L. in a recent issue of *Electrical Engineering* for a diagram of the armature and field winding of a General Electric inter pole, 75 Hp railway motor, I give here such a diagram. This shows the connections of armature and field winding for type 205, G. E. motor, 600 volts with two turns and 25 slots.

H. B. Davis.

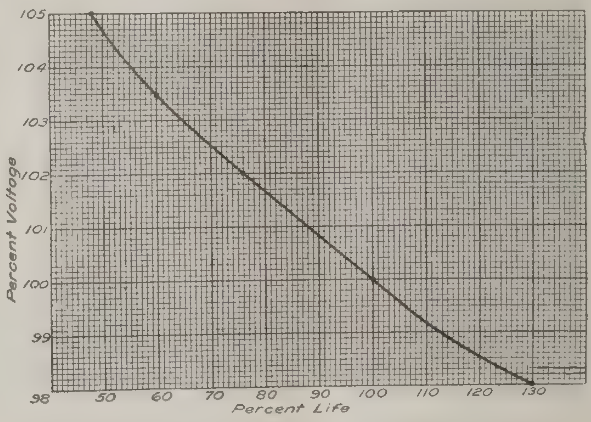


Connections of Armature and Field Winding for Railway Motor.

Life of Lamps on Different Voltages, Ans. Ques. No. 464.

Editor Electrical Engineering:

The accompanying curve taken from data given by J. F. Meyer in the Electric Journal for June, 1911, will probably give the information desired by W. E. C. in question No. 464 of the July issue.



Life-Voltage Curve for Tungsten Lamps.

Large D. C. Motors on 110 and 220 Volt Circuits, Ans. Ques. No. 466.

The power input to a motor is $P = EI$. Now for the same power input, if we have twice the voltage, we only have half the current. Power loss in the lines is $P^1 = I^2R$. Even though the line was large enough to safely carry the current for the 110 volt motor, we would get four times as much line loss as for a 220-volt motor since we have twice as much current and the power varies as the square of the current. This reasoning applies to the motor itself also. A 220 volt motor requires less copper than a 110-volt volt motor and is consequently cheaper to build.

R. H. Willard.

Life of Lamps on Different Voltages, Ans. Ques. No. 464.

Editor Electrical Engineering:

Referring to the curve of Fig. 1, and calling 110 volts, the rated voltage of lamp in question, 100 per cent voltage;

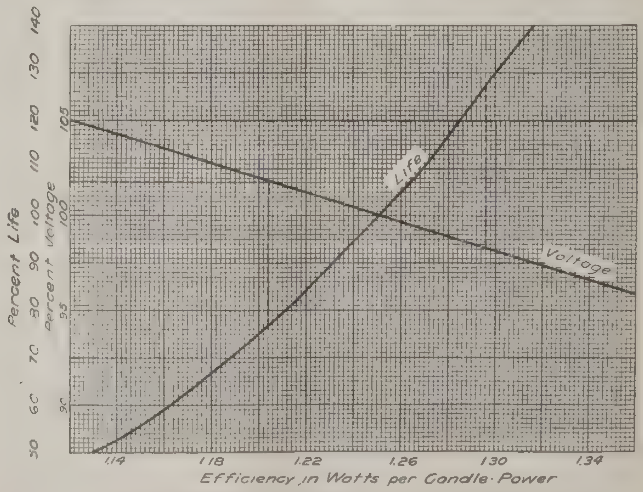


Fig. 1. Characteristic Curves for Tungsten Lamps.

it can be seen by increasing the circuit voltage to 112 volts or 1.8 per cent, that the life of the lamp will be decreased approximately 23 per cent of its life on rated voltage, while on 108-volt supply the life of lamp will be increased approximately 26 per cent. This should answer the question by W. E. C. in the July issue. D. M. Bennett. (Mich.)

Large D. C. Motors on 110 and 220-Volt Circuits, Ans. Ques. No. 466.

Editor Electrical Engineering:

Large D. C. motors are designed to operate on 220 volts rather than 110 for the same reason that long transmission lines are designed for high potential rather than low potential, that is, to effect a saving in copper. Comparing two motors of the same horse power, one operating at 110 volts and the other at 220; it is found from the formula: Current = (horsepower × 746) ÷ voltage, that the 110-volt motor takes twice the amount of current of the 220-volt motor to deliver the same power. H. H. Wikle. (Ohio.)

Why Transformer Burned Up. Ans. Ques. No. 463.

Editor Electrical Engineering:

In any three-phase installation with balanced load at unity power factor, the volt-amperes are equal to the well known value KW/1.732 or .577 K. W. This latter value fixes the minimum rating of the windings required when a connection is made to either of the sides, to respectively supply, transform or absorb the power called for by the installation. If the windings are grouped by either the star or the closed delta method, any single winding is assisted by the others of the group, and requires a rating equal to .577 KW/1.732 or .333 KW. If the windings are grouped by the open delta method, neither winding is assisted by the other, consequently must have the rating first established or .577 K. W. In either case, the load will divide equally between the windings and the current carrying capacity of the group will be limited by the smallest winding of the group.

Therefore, the installation in question is equivalent to two 20 K. W. transformers in open delta, with a group rating of about 34.7 K. W. The fact that one of the transformers is actually a 30 K. W. simply means that this transformer will carry a load equal to that of the 20 K. W. but with less heating. The load given is about 25 K. W. which the transformers should carry provided the power factor is not too low, about 72% being the limit for this group.

The loss of the 20 K. W. by burning out would indicate a power factor less than that given above, which would be the case if the load consisted of several small motors not fully loaded. Another cause might be that the primary fuse common to the two transformers might have blown, causing the motors to operate as single phase at reduced voltage and increased amperage. In this case the load would divide about 60% on the 20 K. W. and 40% on the 30 K. W., the increased amperage causing the 20 K. W. to overheat and burn out.

The given installation should be investigated and the ampere demand and power factor determined and if this latter be found below, say 75%, an endeavor made to bring the power factor to this value or even higher by rearranging the load on the motors until they are as near their full load rating as possible. The new installation should be of sufficient capacity to care for the installation, based upon the kilo-volt amperes instead of the kilowatts. The use of the open delta method of transformation is not restricted by the amount of power to be transformed, the writer having used this method with units of several hundred K. V. A. rating.

Proper Connections for Transformers. Ans. Ques. No. 465.

When the terminals on the secondary windings of a single phase transformer have been rearranged and the proper leads to use for a series or a parallel connection uncertain, the correct leads to use may be found by the following method. The procedure is simple and the necessary apparatus readily procurable, and consists of an ordinary incandescent lamp and socket with two flexible leads, a single phase circuit of approximately 110 volts, the transformer in question and some pieces of wire; lamp cord will do.

Referring to the sketch, B and C are the two wires of the lighting circuit, and A, D, and a, b, c, d are respectively the primary and the secondary leads of the transformer. The test lamp is not shown. Connect one of the secondary leads to one side of the lighting circuit, a to B for instance. Connect one of the lamp leads to the other side of the lighting circuit. With the free lamp lead make momentary contact with the free secondary leads. When the lamp lights the circuit will have been closed through to a. Assume the lamp lights up on b. then a and b are leads from the same coil, and c and d must be from the other coil, but these may be verified if desired.

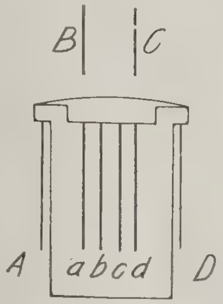


FIG. 1. SHOWING PROPER CONNECTION FOR TRANSFORMER WINDINGS.

So far, so good, a and b are leads from one coil, c and d from the other. Now for polarity, or the leads to use for series or multiple connection. Tie b to c and a to A. Connect A to B and D to C. Test with the lamp from A to D and from d to D. If the lamp is brighter from d to D than from A to D, then A, a and c are leads to similar ends of coils and b, d and D are leads from the other ends of the coils. If the lamp is dimmer from d to D than from A to D, then A, b, and d are leads to similar ends of coils and a, c and D are leads from the other ends of the coils. Which of these conditions or polarities is correct depends upon the polarities of the other transformers with which this transformer may have to be used in parallel. The correction is made by tying a to d instead of b to c. If the lamp shows equal brightness from d to D and A to D, the secondary coils are connected in opposition. This may be corrected by tying a to c or b to d, as may be required for correct polarity. For parallel connections on the secondary side, similar leads are connected.

A magneto may be used to trace the leads, and a voltmeter to determine polarity, a difference of the potential from A to D and d to D indicating the proper series connection, and the same voltage from A to D and d to D indicating secondary coils in opposition. However, the method detailed is simpler and quicker.

Large D. C. Motors on 110 and 220 Volt Circuits. Ans. Ques. No. 466.

The use of large motors wound for service at 220 volts instead of 110 is desirable for reasons which are in addition to the effect of these motors upon the supplying circuit, such as the use of smaller wires from the point of supply to the motor location, less expensive switches at the individual motors and smaller starting devices. The motors may be made more compact, thus saving space at the motor location and allowing ample ventilatig ducts in the motor without an unwieldy bulk.

The operation of the motor is improved in the D. C. type because of the smaller armature currents to be commutated, and the number of brushes may be reduced, thus decreasing the amount of attention given to the brushes. The smaller armature currents also decrease the arching at the contact blocks of the starting rheostat. To sum up, the use of motors on 220 volt service instead of on 110 volts, makes for economy in installing and maintaining a plant of a given horsepower rating. R. Arthur Joslyn.

A. C. vs. D. C. Equipment for a Small Factory. Ans. Ques. No. 470.

Editor Electrical Engineering:

In answer to question No. 470, by W. J. R. in the August issue, the change to A. C. equipment seems feasible for the following reasons: A three-phase, four-wire system is cheap to install and is largely used in factories where constant speed polyphase motors are in demand. High motor potential may be obtained by the use of 2,200 volt motors and the lamps may be operated at 115 volts without the use of transformers. If a change is to be made at some future date from isolated to central station service, it is better to be equipped with A. C. motors than to undergo the expense if D. C. equipment is retined.

With regard to the turbine, it seems folly to talk about installing a turbine in a plant of the size you mention. The eggs are all in one basket and if your turbine needs repairs you are then obliged to shut down. It is not a case parallel to the central station where there are spare machines. It would be advisable to install two or three small reciprocating engines of say 200 Kw. capacity so that two are always running at approximately full load and the other in readiness for a case of breakdown. Suppose you install two turbines of 250 Kw. capacity. First, the economy of a turbine at this rating is questionable as referred to the cost, as opposed to a well designed reciprocating engine of like capacity. Secondly, you always have a means at hand to make the usual repairs to the reciprocating engine while with a turbine it is sometimes necessary to telegraph the manufacturer and wait. This, of course, depends on your facilities.

Reciprocating units could be run non-condensing fairly economically, while to effect a saving with a turbine you would have to run condensing, thus entailing a higher initial cost of such a difference perhaps, that the saving resulting would not be a sufficient return on the investment. For these reasons it seems best to recommend small high speed engines direct conected to three-phase, four-wire generators. Henry A. Cozzens, Jr.

Minimum Size of Plant to Make Use of Stokers and Economizers, Ans. Ques. No. 472.

Editor Electrical Engineering:

Judging from a comparison made between the figures of the Automatic Stoker Company and the results obtained in actual practice, the size of plant justifying the use of automatic stokers varies between wide limits. However, a plant with which I have been familiar has shown itself to be the turning point between loss and economy in the use of one make of automatic stokers. That is, it costs about the same for coal, plus necessary labor, plus repairs and upkeep, as did the same items when the boilers were fired by hand.

The average day load on this plant, due to a heavy power load, is about 2,150 Kw., while the average night load is about 800 Kw. One 2,000 Kw. Curtis steam turbine carries the load from 6 A. M. to midnight, or 18 hours. It is relieved during the six morning hours by a 900 Kw. alternator driven by a cross compound noncondensing Corliss engine.

With conditions as stated above, steam was supplied by two sets of horizontal water tube boilers rated at 500 boiler horsepower per set, and by one vertical boiler of 5,500 boiler horsepower. A boiler horsepower of 1,000 was the usual capacity carrying the above stated load, as one set was off the header undergoing repairs most of the time. This caused a heavy overload to be carried when the peaks came on which burned out the fire-brick arches in short periods, necessitating short periods between repairs. Thus, what was saved in labor and in coal by the use of the stokers was lost in replacing fire brick in the arches. The stokers are of the inclined grate type. I should conclude from the experience we have had that plants having a capacity of less than 2,500 or 3,000 Kw. installed would lose money by putting in automatic stokers.

As to steam pressure, this is not a vital item. The energy transferred from the fire to the turbine depends on the number of B. T. U.'s which the steam carries, not at what pressure they are carried. We operate under 150 pounds gage pressure, with the usual vacuum obtained in the above size of turbine condenser. Any of the usual pressures would be satisfactory. A. U. Avera.

Starting Two Motors from One Auto Starter. Ans. Ques. No. 473.

Editor Electrical Engineering·

Referring to the question of E. P. S. in your August issue, and to the diagram accompanying same (reproduced as Fig. 1) there is no objection in a general way to the use of a single starting-compensator of suitable capacity for the starting of two or more induction motors, either separately or at the same time and such practice is not uncommon. Whether or not the proposed installation would transgress the spirit of the underwriters' rules would depend upon the details of the installation and not upon the main question.

The arrangement as suggested by E. P. S.'s diagram (Fig. 1) would work, but it does not allow for the starting of motor No. 1 while motor No. 2 is running normally and it also does not show any separate protection for the motors. It would, therefore, be better to modify the arrangement as shown in Fig. 2, which allows for the starting and stopping of either motor without regard to the other, as well as for starting both motors at once if so desired.

Each set of feeders for the motors when connected in the running position must be properly fused as required or protected by circuit breaker or automatic oil-switch and the main feeders for supplying the current to the starting compensator must also be suitably fused. Whether or not fuses are also required upon the separate branch feeders upon the starting side of the individual motor switches will depend somewhat upon the size of branch feeder wires used for the motors, also upon the size of starting-compensator used and upon the size of line wires to same, also upon the size of fuses used to protect the latter. With motor wires of generous size, the starting branches to two 15 Hp. motors, as per diagram, would ordinarily not require any separate protection if fed by a 30 Hp. starting-compensator, provided the line wires feeding this compensator were protected by fuses of proper size, which would usually be of capacity about 50% above normal amperes for 30-h.p. running load. But if a 50 Hp. compensator-starter were used for this service and if the line wires were normally fused for a starter of this capacity, it would then usually be advisable to also fuse (or otherwise protect) the separate branches carrying the stating current for each of the motors. If, therefore, two 15 Hp. motors would be the ultimate installation, there would be no advantage in using a starting-compensator larger than 30 Hp., as this would suffice for starting both motors at once when so required. However, if a third 15 Hp. motor might be added later, the starting-compensator should be of 50 Hp. capacity.

While it is quite practicable to use one starter for two or more motors as shown, or with several other modified arrangements, such method rather complicates matters, and leaves it always possible to accidentally close either motor switch directly upon the main line at full voltage, instead of starting up through the compensator. It leaves the running fuses always "alive," unless additional switches (not shown) are placed in each motor circuit, above the running fuses. It also sacrifices the advantage of all the good features which are obtainable by the use of separate starting-compensators for each motor, as such compensators are now made standard with low-voltage release coils and self-restoring starting handles, also with combined running fuses or overload circuit-breaking coils as required.

The sketches show open knife-blade switches, and it is therefore assumed that the voltage used is low, and that other conditions are such as to make the use of such style of switch allowable. Of course, in order to keep any financial advantage from the small economy effected by the use of one starting-compensator for two or more motors, as described, it necessarily follows that the owners will desire also to have all switches and incidental equipment of as simple and inexpensive type as possible. For any dangerous location or any dangerous voltage, and generally for any high-grade motor installation, suitable approved oil-switches or other enclosed types of switches should be used in preference to open switches.

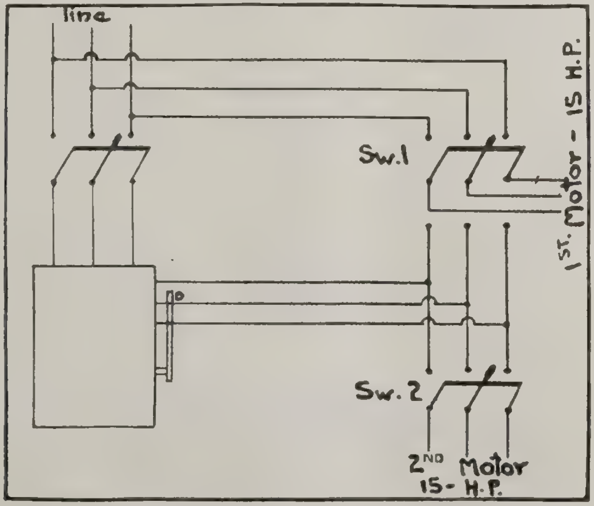


Fig. 1. Connections for Starting Two Motors by E. P. S.

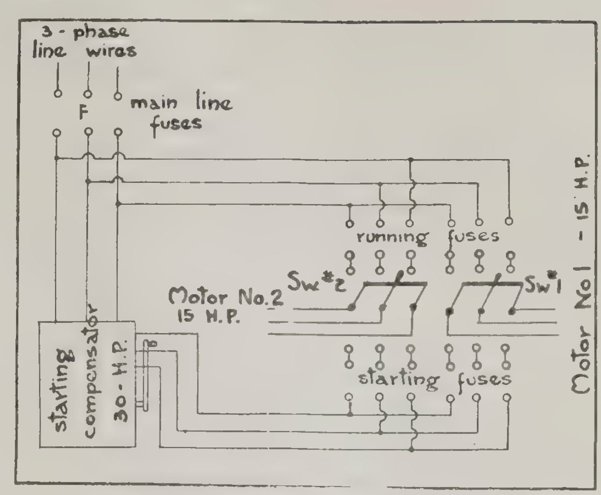


Fig. 2. Proper Connections for Starting Two Motors with One Compensator.

Th term "starting-compensator" is here used in preference to "auto-starter," as the latter term is now rather ambiguous and gives the idea of an automatic or self-starting device, which was evidently not intended in E. P. S.'s question.

As the ordinary compensator starter includes a self-contained oil-immersed switch, the main knife switch for the compensator shown in Fig. 1 is omitted in Fig. 2. It is important to note that, with the arrangement shown in Fig. 2 after either motor has been started up to speed by the compensator, the motor switch must then be at once thrown upwards to the running position, or it will not then be protected by fuses of suitable capacity for the running-load current. V. C. Wynne.

Starting Two Motors From One Auto-Starter, Ans. Ques. No. 473.

Editor Electrical Engineering:

The writer does not believe that two motors can be started from one starter satisfactorily, using the connections given by E. P. S. in the August issue. No fuses are shown at all, so that the fuses on the main line would have to carry about three times the normal current taken by both motors at starting and wire of the same carrying capacity as the fuses used to the motors. Each motor should be protected after starting by fuses of not more than 50 per cent above rated capacity of the motor at full load. The starter should have a no-voltage release so that when the power is cut off and then thrown on again the fuses will not blow, for the motors will then be disconnected from the line.

I am advised that a compensator allows only a certain amount of current to flow, yet a 30 horsepower starter required to handle the two motors as shown would allow enough current to flow when one 15 horsepower motor was started to burn it out. A starter for each motor would be the cheapest arrangement in the long run.

W. W. Sackett.

Single Phase Lighting from 3-Phase Circuits. Ans. Ques. No. 474.

Editor Electrical Engineering:

The method shown by Mr. Gibson in question 474 in the September issue is not correct, due to the reactance of the transformer winding disturbing the phase relation in the 110 volt circuit. This will cause a too high or too low registration depending on the direction of phase rotation. A single phase meter should be inserted in the 110 volt single phase circuit. For proof of this error see Electrical Meterman's Handbook, pape 166. (Published by National Electric Light Association, New York City).

Overloading Instrument Transformers. Ans. Ques. No. 476.

It is presumed that overload refers to the load on the secondary of the instrument transformers and not the load of the circuit to be metered. In both potential and current transformers the ratio increases as the volt-amperes of the secondary increases and this will cause lower registration of a watt-hour meter. Connecting other instruments and devices than the watt-hour meter to the current and potential transformers naturally increases the load in volt-amperes on the secondaries of these transformers.

W. H. Fellows.

Single Phase Lighting from 3-Phase Circuit. Ans. Ques. No. 474.

Editor Electrical Engineering:

The following is an answer to question No. 474 in the September issue of Electrical Engineering. This question may be answered without the aid of diagrams or mathematical analysis, for it is evident that the three-phase power load is metered correctly under all conditions of power factor and unbalancing, as the connections for this load are according to the standard two-wattmeter method of measuring three-phase power and hence do not need further demonstration. It remains to consider the single phase lighting load.

If the load on the lighting current is exactly 100 per cent power factor, which would be the case on a purely lighting load with a short transmission line, and the wattmeter is correctly calibrated for 50 per cent power factor and the voltage triangle of the supply circuit is exactly balanced, the lighting load will be correctly metered. This is true for the reason that the current of the lighting load all passes through the current coil of one wattmeter movement, the corresponding voltage coil has double voltage impressed upon it but 60 degrees in leading phase displacement from the current. The component of the voltage in phase with the current is equal to the line voltage on the lighting circuit, or 110 volts. This component multiplied by the current gives the power consumed in the lighting circuit, which power is measured by one movement of the wattmeter and independent of whatever load may be passing in the three-phase power circuit.

The disadvantages of such a system are, however, such as to render this system of metering impracticable in any ordinary commercial application. The accuracy is very much affected by slight unbalancing of the circuit. A distortion of the triangle by as much as five degrees either way would cause in itself an error of some 8 per cent. The ordinary regulation drop in the windings of commercial transformers, when there is an appreciable load on the three-phase circuit, might greatly change the angle between the current and voltage in the wattmeter movement which measures the lighting load and make the readings practically worthless. The wattmeter would need to be calibrated for a low power factor or a considerable error would result from this cause. A very slight lag in the power-factor of the lighting circuit load would produce a large error and, should this power factor be reduced to 87 per cent, due to the addition of small single-phase motors, no power at all on account of this circuit would be recorded by the wattmeter. Under these conditions the current lags 30 degrees behind the supply voltage, but the current and voltage in the wattmeter are at right angles to each other and their product in a vector or power sense is zero.

An exact statement of the amount of the error resulting from these various causes is not capable of intelligent presentation since there are many ways in which the voltage triangle may be unbalanced or the load conditions vary. Any particular analysis would not fit the general case, the proof must depend upon intuitive reasoning or experience. The point illustrated by this problem is recognized as a danger to be avoided by all those versed in the theory and practice of metering, and is one that is frequently encountered.

Harvey S. Pardee.

Single Phase Lighting from 3-Phase Circuit. Ans. Ques. No. 474.

Editor Electrical Engineering:

It would be possible to measure a non-inductive load in this manner, if the angle of displacement between the potential of the meter and the single-phase current were 60 degrees, the cosine of which is 0.5 so that the meter would measure one-half of the current in the single-phase times the potential on the meter.

However, this is not possible, since the voltage triangle of the phases will be changed by the reactance in the transformer winding changing both the phase angle and the voltage A. C. The error resulting from the change of phase angle from 60 degrees will be greater than that due to the higher voltage of the A. C. phase and the two errors are in the same direction.

J. G. Longfellow.

Central Stations in Great Britain and the United States.

There were, in the United Kingdom, approximately 460 stations, according to the published list of June, 1912. For the United States the records of the same date show about 5,900.

In England the larger communities only are served, 75 per cent of the plants being in towns of over 10,000 population. In the United States 85 per cent of the central stations serve places of less than 5,000 population.

Municipal ownership is to a large extent private ownership, in the sense that the taxpayers are, in their private capacities, virtual stockholders, but without the advantage of limited liability, while the so-called "private" enterprise is in a large measure public, both in the nature of the service and the wide distribution of securities.—A. K. Baylor, in The Annalist.

New Apparatus and Appliances

New Weston Instrument Transformers.

New designs of switchboard and portable instrument transformers have recently been announced by the Weston Electrical Instrument Company of Newark, N. J. It is generally recognized that instrument transformers should be designed and made with a much greater degree of refinement than is necessary in commercial lighting and power transformers, so that these new contributions to the art of electrical measurement by the Weston Company are of special interest.

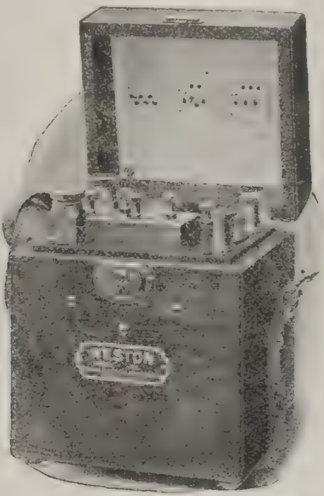


Fig. 1. New Weston Portable Current Transformer.

Two different models of portable current transformers are made, one type with three self contained primary windings and the other of the inserted type, the ratio depending upon the number of turns of the primary that are passed through the aperture. A portable potential transformer is also made in various ranges.

The manufacturer emphasizes the point that these transformers are unequalled in precision, in design, in workmanship and reliability in service. Special stress is laid upon the accuracy, the ratios of transformation, and upon the fact that the design and proportions of the transformers are such that it is unnecessary to have instruments specially calibrated with them in order to obtain the degree of accuracy to which high grade instruments are guaranteed when used without transformers. This feature is of special interest in connection with tests with portable instruments, because in many quarters the impression has prevailed that no transformers could be made that would assure the users of the degree of accuracy for which a high grade portable instrument is designed, unless special precaution had been taken to calibrate a particular instrument with a particular transformer.

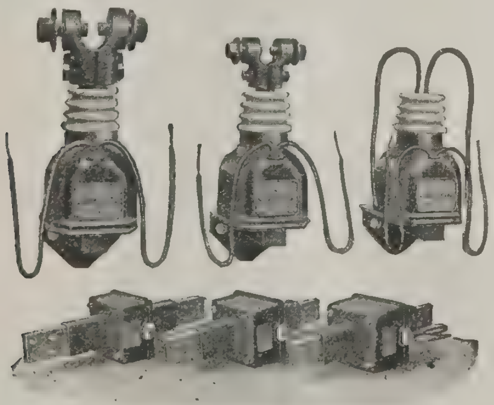


Fig. 2. Types of Primary Windings for Current Transformers.

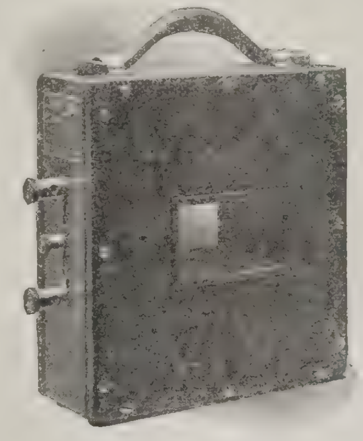


Fig. 3. New Weston Portable Potential Transformer.

Insulating Cover for Dossert Connectors.

A new insulating cover for use with the solderless connectors made by Dossert and Company, 242-44 West 41st Street, New York City, has been placed on the market. This cover is designed for the No. 4 connector which can be used with conductors in sizes No. 4 to No. 14 inclusive, either solid or stranded. The accompanying illustration shows the insulating cover and connector in approximately actual size. It is claimed that this arrangement makes possible a saving of about 20% as compared with cost of connector and cover heretofore supplied.

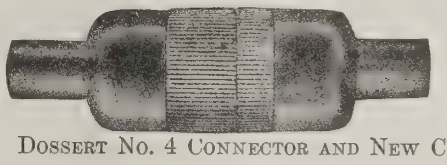


Fig. 1. Dossert No. 4 Connector and New Cover.

New Types of Bus Bar Supports.

New designs of bus bar supports and special porcelain have been produced by the General Devices & Fittings Company, Chicago, Ill. In designing the porcelain part care has been taken to produce an even distribution of stresses and strains over and throughout the porcelain parts. The voltage requirements for safety factor and the results of flash over and arc over tests were also given consideration. A certain piece of porcelain may arc over before puncture, but it is claimed that it is not generally known that cases exist where this particular piece of porcelain should puncture before flashing over. New high frequency testing equipment has made it possible to determine where a piece of porcelain should be reinforced or the dielectric decreased. This means that some porcelain should be reinforced at the voltage point and weakened at the ground point, and other porcelain of similar nature should be reinforced at both points.

Mechanical cushioned clamps instead of cement are used for the reason, it is said, that the dielectric change in porcelain due to the use of cement is one of the factors that causes aging and fatiguing of porcelain carrying large currents.

The pyramid type porcelain bus supports shown in Fig. 1 are designed with small thin corrugations beginning at the voltage point and tapering wider and deeper to the ground point, primarily to reduce the electrostatic field. A safety factor of 4½ to 12 times, is used, depending upon the service voltage impressed on the porcelain part, the larger the kilowatt capacity being supported the greater the safety factor and the more rigid the support to take care of this feature. It is claimed that bus bar equipments in certain plants have shown, by careful test, that they are subject to a magnetic pull as high as 455 pounds per lineal foot of bus. It is therefore proper that bus supports should be specified to take care of these situations, knowing that this magnetic pull will be increased tremendously through a short circuit, motorizing, inductive troubles, etc.

Fig. 1 shows a bus bar support for 22,000 volts with a guaranteed test, all assembled, of 112,000 volts. This support carries a ceramic factor of 1.29. This support is set on an insert which was designed to be molded into the concrete floor of compartments. This bus bar support will hold a strain exceeding 1,200 pounds per square inch. The cut shows two laminations of ¼-inch bus bars with one filler. These supports are designed to hold any size or capacity of bus bar. Fig. 2 shows a standard bus bar support equipped for holding flat buses on the horizontal and for mounting on pipe frame, this support having two "U" bolts.

Fig. 3 shows a bus bar support for supporting buses in vertical position and for mounting on pipe frame. This pipe frame support has a set screw in the lower clamp to prevent the support from turning on the pipe and is used where supports like figure No. 2 are too wide for close work. Fig. 4 shows a bus bar support for mounting buses in a vertical position with a flat base and center bolt clamping arrangement. It can be slipped over a bolt which has been imbedded in the concrete structure and turned in any position.

Fig. 5 shows a bus bar support carrying a round bus of any description. It is shown with a popular skeleton type base for mounting on flat surface. Fig. No. 6 shows a bus bar support for holding large insulated cables or bare cables as the case may be, and is shown with a compartment type base. This enclosed base is hollow in the bottom and drops over a stud, which may be cemented in the compartment floor, and is much in demand where height is limited.

All the above supports are designed so that any of the bottoms or any of the tops can be used to suit conditions. Fig. 1 support can be furnished either as a double support, three way or four way support, and arranged to carry bases on the vertical, on the horizontal, or special tubular buses, and all supports can be adjusted to any angle by simply unloosening the clamps.

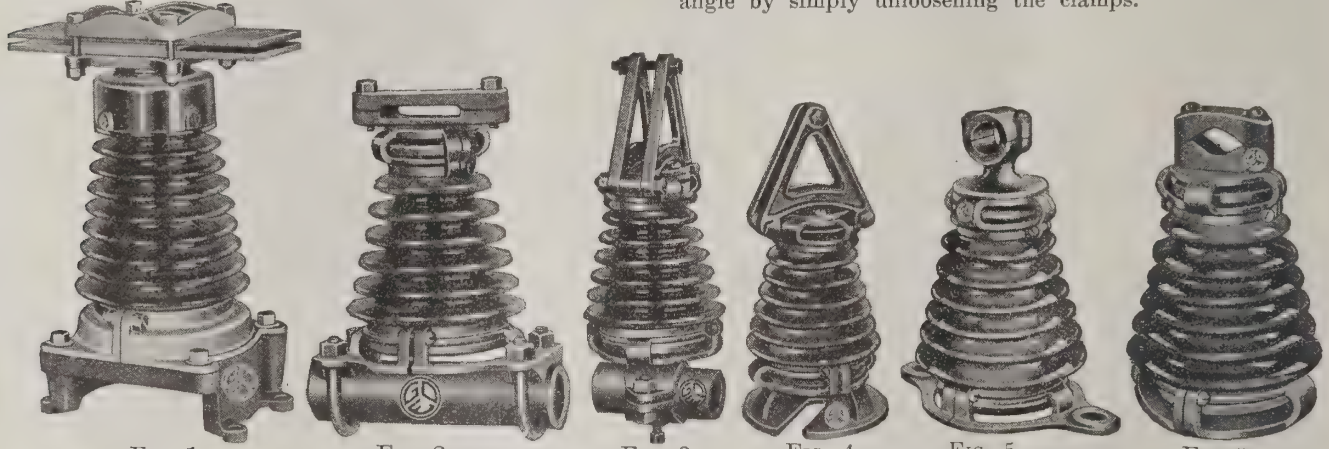
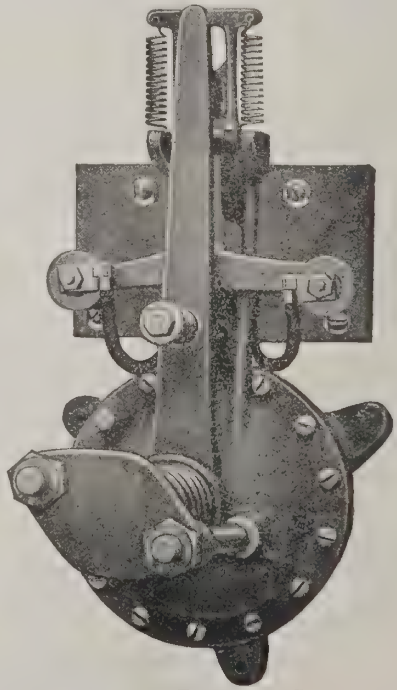


FIG. 1. FIG. 2. FIG. 3. FIG. 4. FIG. 5. FIG. 6.

FIGS. 1, 2, 3, 4, 5 AND 6 NEW TYPES OF BUS BAR SUPPORTS.

New Automatic Pressure Regulator for Starting and Stopping Small Motors.

The double pole diaphragm type pressure regulator illustrated below is a new device for automatically controlling small direct or alternating current motors operating on pressure systems. This regulator stops the motor when the maximum pressure desired is reached and starts it again when the pressure drops to the low value for which it is set. For capacities within the limits for which it is designed (1 H. P. for D. C. and 5 H. P. for A. C. motors), this regulator controls the operation of the motor without



CUTLER-HAMMER PRESSURE REGULATOR.

an additional magnetic switch and automatically maintains pressure in the systems between given limits. This device is made by The Cutler-Hammer Mfg. Co., of Milwaukee, Wisconsin.

A New Bryant Switch.

A new snap switch for use on electric range and other heating circuits, has been produced by the Bryant Electric Company, Bridgeport, Conn. This switch is arranged for three settings, the first connecting into circuit all the elements it controls, the second being for medium heat, the third low and fourth for the "off" portion. In this way the degrees of heat are provided in the order in which they are most used and a smaller switch than otherwise can be used. The indicating dial for the switch is set at an angle of 45 degrees so that the heat position of the indicator is always visible. The switch shown is of 2.5 Kw. capacity. A 5 Kw. switch is also made.

New Bryant Switch for Electric Heating Circuits.

Despatch Portable Electric Heater.

A moderate priced electric heater to meet a popular demand and one that can be attached to the ordinary electric light socket and give a maximum heat for the amount of current consumed has been designed by the Dispatch Mfg. Co., of Minneapolis, Minn., and shown in the accompanying illustration.

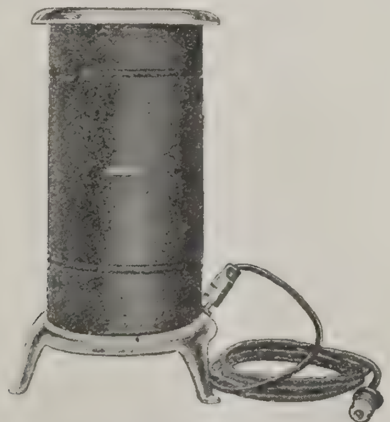


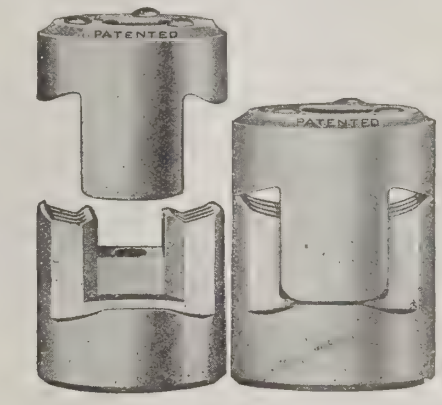
Fig. 1. The Dispatch Electric Heater.

This is not a radiator and despite its ample heating capacity is said to not become hot enough to burn one who touches it and can be used in nurseries without danger to children. The principle applied in this heater is that of circulation; the air being drawn in cold at the bottom and given out heated through the top. This tends not only to rapid and uniform heating, but to better air.

The heater is not designed to take the place of furnaces, etc., but is intended more particularly for use on chilly mornings or evenings in bathrooms, nurseries, sick-rooms or any place where heat is desired quickly. The heater occupies less than one square foot of floor space, stands eighteen inches high and draws 660 watts. Heaters are built for 110 volts, but orders for 220 volts can be filled.

A Reversible Split Knob.

A type of reversible split knob to be known as the "Buckeye" has been designed by the Findlay Electric Porcelain Co., of Findlay, Ohio, and shown in the accompanying illustrations. This knob has two wire grooves with an interlocking feature which keeps the parts in place while being installed. The wire way is of triangular shape and grips the wire without injury to insulation. The knob is made in both round and square designs with the two pieces alike making it unnecessary to count or match tops and bottoms. The knob is made in three sizes, 1⅛ x 1⅛ inches for the square and 1⅛ and 1¼ inches in diameter for the round pattern.



The Buckeye Split Knobs.

A New Design of Dim-a-Lite.

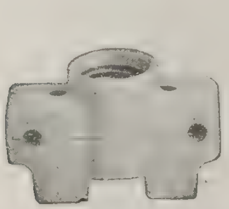
A new design, a "Dim-a-lite," including a fixture socket, Dim-a-lite and shade holder has been produced by the Wirt Company of Philadelphia, Pa., which can be used where there is danger of the dimming device being removed or stolen. This new design is shown in the accompanying illustrations and can be used in the same way as any ordinary socket.

The New Dim-a-lite Installed.

The dimming features are the same as in the standard pull chain "Dim-a-lite," but the operation is entirely different. Instead of pulling a chain to obtain the different degrees of light, a turning of the shade secures the five changes of light, *viz.*, "full on," "dim," "low," "night light," and "out." The dimming is effected by use of a series of helically wound resistance coils, properly insulated and conneceted to contact bars. The coils are all zero temperature resistance coefficient wire moulded under pressure in a stonelike insulating composition, known as "dielite." The wires are well protected from oxidation or mechanical injury, as the wire and dielite form a solid body. By turning the shade, this resister drum is rotated, and the various degrees of light are secured, as the point of contact shifts from one commutor bar to the next.

A Decorative Outdoor Receptacle.

A new outdoor receptacle has been designed by the H. T. Paiste Company for use on the Garden Pier, at Atlantic City. It has been designed to suit the style of architecture, and glazed a dark brown to harmonize with the tiling. The binding screws are well protected, and are center spaced so that both wires may be bared at the same place. The wires are carried one inch above the surface wired over. Drip holes are provided from the screw shell. The center contacts are of phosphor bronze, as in all Paiste sockets and receptacles. This receptacle as well as all Paiste products is being placed on the market by The Hart & Hegeman Mfg. Co., Hartford, Conn.



A New Paiste Receptacle.

A New Push Button Tool Handle Switch.

The increasing development and use of portable electrical devices has caused a demand for switches that may be so installed as to give most convenient control. With some devices the cord switch is well adapted but for those tools or devices having handles it has been sometimes found more practicable to place the switch in the handle itself rather than on the cord. The portable vacuum cleaner is an example of the type of device to which the new tool handle switch has been successfully applied. This switch is made by The Cutler-Hammer Mfg. Co., of Milwaukee, Wis., and has the same high capacity quick make-and-break mechanism as other Cutler-Hammer switch devices, the mechanism being enclosed in a fiber cylinder ready for installing in the handle. The outside diameter of this fiber cylinder is only one inch. Extra strong light and dark indicating push buttons are used and accessible terminals are located on one side of an insulating wall which separates them from the mechanism. Since this switch becomes a part of the device it controls, the Underwriters approval is secured with the device and not separately.

New Cutler-Hammer Switch.

The Telesign.

Based upon the fact that the merchant's show window is his best salesman, the Telesign Company, 2212-16 Sedgwick Street, Chicago, Ill., has devised a unique and inexpensive show-window electric sign, on which patents are pending. The accompanying illustration shows a two-line device, one of several types made. The design is such that different illuminated cards can be shown and the reading matter changed as desired. Each outfit includes over 200 letters, characters, etc., with four sets of color slides, red, yellow, green and blue, so that any wording can be shown in various colors. By means of a flashing device, a flashing effect can be produced.

The window sign shown in Fig. 1 has spaces for 36 letters, and equipped with an automatic flashing device and four 25-watt tungsten lamps, with cord, plug, chain and hooks for hanging. The sign is 51 inches long by 12 inches high and 7.5 inches deep with letters 4 inches high by 2.5 inches wide. The reflector used is open at the bottom so that goods placed below can be illuminated. The frame of the sign being of Circassian walnut gives it a neat appearance. This sign should find a ready market and appeal to central station new business managers, since it can be used for any business and is effective, neat and durable at a moderate price, the complete outfit as shown in Fig. 1 costing around thirty-five dollars.

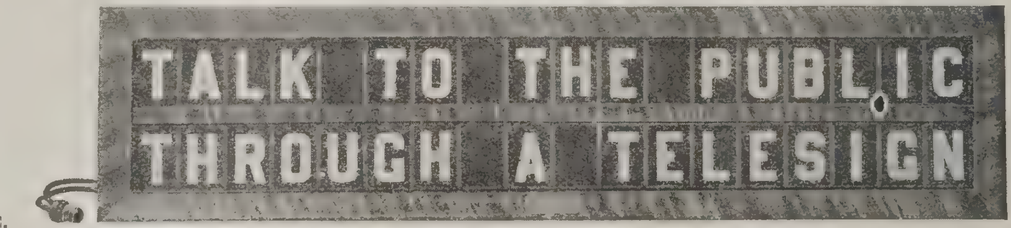


Fig. 1. The Telesign for Window Advertising.

A New Show Case Lighting Unit.

A new show case lighting unit has recently been placed on the market by the Holophane Works of the General Electric Company, consisting of a tubular tungsten lamp and properly designed reflector. The tubular lamp is one inch in diameter and twelve inches long from the contact of the medium screw base with which it is equipped to the tip of the lamp, and, having a medium screw base, the lamp fits the ordinary socket. It is made in two wattages—25 and 40. The single drawn wire filament extends practically throughout the entire length of the bulb, thus providing a running line of light. In order to make this length of filament of high enough resistance to be used on ordinary lighting circuits, the entire filament is twisted into a very fine spiral—a fact which can be seen through a microscope.

The reflector is made of brass, and, when in position in the upper front angle of the show case, occupies a space 14 inches long, 2½ inches wide and 2 inches deep. It has an interior finish of Cleanezy aluminum—the most efficient metal reflecting surface. The contour of the reflector is especially designed to present a neat appearance, to give the most effective distribution of light, and to shield the eye from the high intrinsic brilliancy of the lamp filament.

The unit is readily installed by raising the glass top of the show case, supporting the reflector from the upper edge of the upright glass by means of two brass brackets, and then lowering the top. The two brass brackets are made to fit the thickness of the plate glass ordinarily used in show cases. The lamp socket is mounted on a hinge, which facilitates the removal or insertion of the lamp after the reflector is installed. In order that the lamp may not swing out of the reflector when in use, it is held rigidly by a wire clasp situated on the reflector near the tip end of the lamp. A series of these reflectors can be used along the entire upper front edge of the show case, close enough together that no open intervals will be left. Or the units may be placed at certain intervals along the case. If placed close together, a sliding brass moulding on the back of the reflector protects and conceals all the wiring. If the units are placed at intervals, short lengths of round brass tubing may be used to conceal the wiring between the units.

Improvements in High Capacity Motor Operated Oil Switches.

Certain structural changes have recently been made in General Electric motor operated types of oil switches. The circuit rupturing parts have been made more accessible for inspection, adjustment or repair. The cap on the oil vessel, as well as the lower oil vessel clamp, have been changed to allow bolting metal straps between the cap and clasps, as shown in the illustration. These straps have added considerable strength to the means for securing the cap in position, a valuable feature when the switch is called upon to open heavy overloads or short circuits.

For inspecting readily, contacts and oil vessels, switches up to and including 3,500 volts embody easily removable features. These are shown in the illustration of a single pole of the switch, with one of the oil vessels and movable secondary and fixed contacts removed. Any such unit can usually be removed and replaced in a short time.

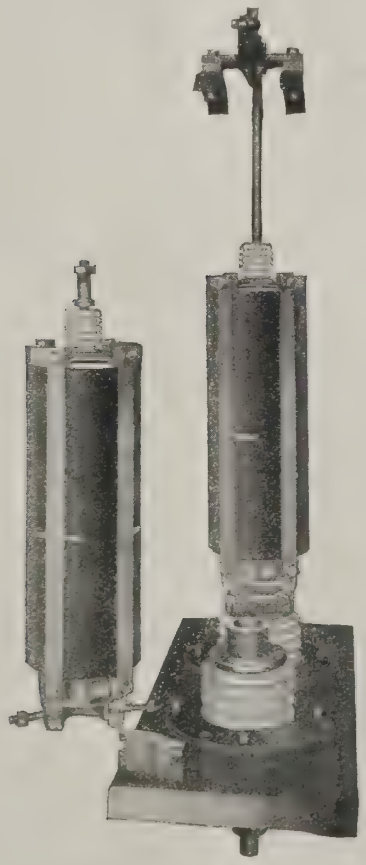


Fig. 1. Single Pole of Oil Switch.

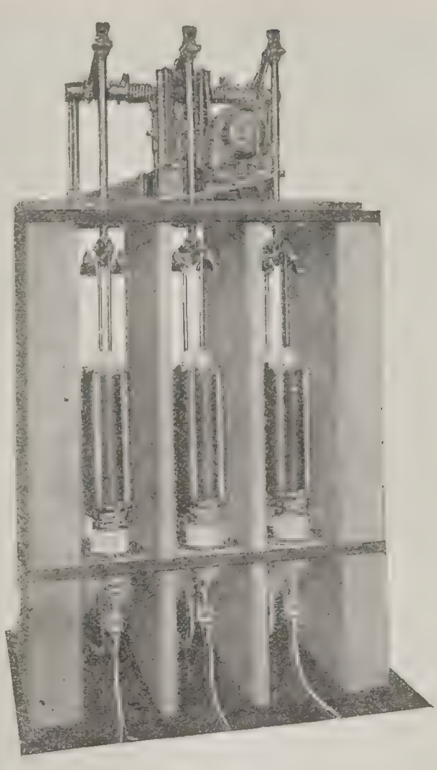
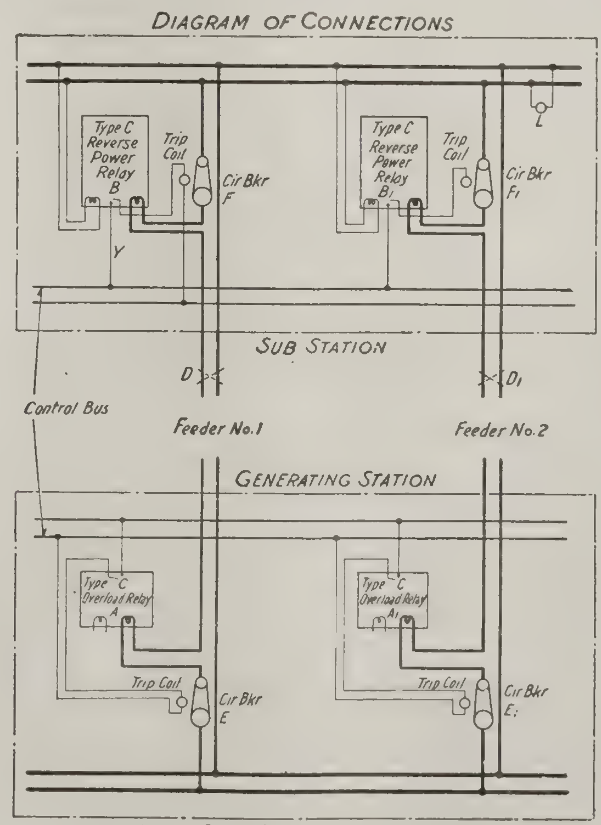


Fig. 2. 15,000 Volt 1,200 Ampere Triple Pole Single Throw Oil Switch.

Reverse-Power Relays for Protection of Parallel Feeders.

In case of a short-circuit or ground on feeders to a substation, a selective reverse-power relay that will not operate on overload is the only means for completely insolating the feeder, the reversal of power at the substation end causing the relay on the defective line only, to operate. Two parallel feeders from the generating station to the substation are shown in Fig. 1. For simplification, the lay-out is single-



Relays for Protecting Parallel Feeders

phase, but three-phase operation is similar when three relays are so connected that voltage and current are in phase in each relay. At the generating station are plain overload relays, set for a comparatively long time element. At the substation are two sets of Westinghouse selective reverse-power relays, one set for each feeder. When the direction of power is normal—both feeders supplying power to the substation—the reverse-power relays cannot trip their breakers no matter how heavy the load may be.

Now if a ground or short-circuit occurs at D on Feeder No. 1 there will be caused a heavy current on both feeders, for Feeder No 2 will supply power through the substation and back on Feeder No. 1 to the point of short-circuit. Thus the direction of power is reversed at relay B in the substation. This reversal of direction of power is the only thing that can cause relay B to operate. As soon as circuit-breaker F is opened, the load on No. 2 feeder falls back to normal, and it continues to operate the substation.

Electrical Construction News

This department is maintained for the benefit of contractors, dealers, manufacturers and consulting engineers.

ALABAMA.

FLORENCE. The Allentown Power Company has been incorporated with a capital stock of $200,000 to develop water power on Cypress Creek. It is understood that two hydro-electric plants will be built. Ernest Thompson is president, of Birmingham; T. W. Pratt, vice-president, of Huntsville; and T. H. Allen, secretary and rteasurer, of Florence.

COLUMBIA. The Columbia Power Company has been recently organized with a capital of $16,000. This company is to build an electric plant on the Chattahoochee River. R. E. Crawford, of Dothan, is interested.

FLORIDA.

GULFPORT. The Bay View Hotel and Development Company, according to reports, has plans fo rthe installation of an electric light plant. J. F. Davenport is manager.

JACKSONVILLE. The city is contemplating placing overhead distribution in underground conduit on Main Street.

JACKSONVILLE. The Arlington Water & Electric Company proposes to construct an electric lighting system and water system in the Arlington Heights section. This company was recently incorporated with a capital stock of $10,000. J. F. Zetsche is president.

LEESBURG. It is understood that the Leesburg Ice Co., is to build an addition to its power plant and install a 200 horsepower engine and a 125 K. W. generator, with switchboards and a 250-gallon motor driven centrifugal pump. Transmission lines will also be extended and additional transformers and motors purchased.

PABLO BEACH. The city voted on September 15th to issue $10,000 in bonds for the construction of an electric light plant.

OCALA. The city will vote Ocotber 27 on the issuing of $55,000 in bonds to enlarge its electric light plant and build an ice plant.

ZOLFO. The Zolfo Electric Company is to construct a power house and install electrical equipment sufficient to light one-thousand incandescent lamps. H. Z. Murphy is president of the company.

KENTUCKY.

BEATTYVILLE. The Beattyville Utilities Company has been incorporated with a capital stock of $10,000. The incorporators are H. S. Van Zant, of Frankfort, and E. P. Bullock, of Louisville.

HENDERSON. The city is to build a new boiler house and rebuild a portion of its electric light plant. Plans and specifications are in the hands of L. P. Hite, Superintendent.

LOUISIANA.

ABITA SPRINGS. A lighting plant is to be installed and an overhead line distribution for street and residence lighting.

BUNKIE. The Bunkie Ice Company is negotiating with the city to secure the municipal lighting plant at Bunkie Brick Works. If this plant is secured additional equipment will be installed.

NEW ORLEANS. It is understood that a company will be installed, with a capital of $10,000,000 to build hydro-electric plants outside of New Orleans.

MISSISSIPPI.

JACKSON. A property of the Jackson Light & Power Company has been purchased by R. L. Benson, of Chicago. This purchase is subject to a confirmation by a referee in bankruptcy.

NORTH CAROLINA.

HIGH POINT. It is understood that the North Carolina Public Service Company is planning an ornamental street lighting system for the business district, to consist of sixty standards carrying 60-watt lamps.

MURPHY. According to reports the Carolina, Tennessee Power Company of New York City, 115 Broadway, is making surveys for dam sites on the Hiwassee River. It is understood that the main development composed by the company consists of a dam 180 feet high sufficient to develop 70,000 horsepower, and that energy will be transmitted to Murphy and other North Carolina towns.

WINTON. It is understood that the city plans to construct a water power plant and enlarge its present equipment. R. V. Turner is town clerk and can give other information.

WINTON. The J. W. Smith Electric Company, of Winton, is to construct an electric light plant at this place. The first installation will be steam power, it being proposed to develop a water power site later.

PERSONALS.

F. F. FOWLE, Consulting Electrical Engineer, who some time ago was appointed one of the receivers of the Central Union Telephone Co., has found it necessary to close his New York office at 68 Maiden Lane, and establish headquarters in Chicago. While Mr. Fowle finds it necessary to give practically his entire time to the work of the Central Union receivership, he has in no way retired from the consulting engineering field. It wil lbe remembered that the above mentioned receivership grew out of a suit by the minority stockholders alleging mismanagement and improper use of resources to the special advantage of the American Telephone and Telegraph Co. The receivers are now operating and managing the property valued at approximately $35,000,000 and located in the states of Ohio, Indiana and Illinois. Mr. Fowle has offices in the Telephone Bldg., Chicago, Ill.

MR. WILLIAM SPIRO has recently been appointed Southern manager of the Telesign Company of Chicago, Ill., manufacturers of an illuminated changeable advertising window device in the shape of an electric sign. Mr. Spiro came to Atlanta on September 1st and has established temporary headquarters at the Piedmont Hotel. He plans to carry an extensive stock and travel salesmen in the states of Florida, Georgia, Mississippi, Alabama and Louisiana. Considerable interest has been shown in the device by central station managers as it meets a demand for an effective and inexpensive window advertising device that can be used by all classes of trade.

MR. THOMAS E. HUGHES, manager of the Philadelphia office of the Standard Underground Cable Company, died at his residence, Atlantic City, N. J., August 27th. Mr. Hughes had long represented the Standard Company throughout its Atlantic Coast territory from Philadelphia South, and for the past seventeen years had been manager of its eastern and southeastern branch office sales department located at Philadelphia. During the period of his association with the company he had seen the number of its branch offices increase more than five fold, and the annual business done in the Philadelphia office territory during recent years grow to a figure equal to that of the company at large seventeen years earlier. Mr. Hughes has been a well-known figure in the electrical field. For a number of years he was secretary and director of the Manufacturers Club, of Philadelphia, and until his death took a great interest in the Club's activities. Prior to his connection with the Standard Company, Mr. Hughes was connected with John A. Roebling Sons Company, at Trenton and Scranton, and with the Washburn & Moen Manufacturing Company at Worcester, Mass., and Pittsburgh.

INDUSTRIAL ITEMS.

THE DETROIT INSULATED WIRE CO., of Detroit, Mich., is erecting a new saw tooth building 57 x 138 feet, of steel construction, and a wood working unit 35 x 50. The new building is required to provide space for more equipment, and the general offices of the Company, the present quarters occupied for this purpose being required for factory use. The additional machinery and equipment has been provided, and when installed will materially increase the company's production.

THE ROBBINS AND MYERS CO., Springfield, Ohio, on August 8, held its annual picnic for employes. This picnic has become a important event of the year among all employees of the company, and was attended this year by some 2,000 men and women. An elaborate program was carried out.

THE GREENWOOD ADVERTISING CO., of Knoxville, Tenn., manufacturers of electric signs, has opened an eastern office at 1510 Sansom Street, Philadelphia, Pa. This office will be in charge of F. J. McCormick. Norman B. Hickox is manager of the company at Knoxville, Tenn.

CHICAGO ELECTRICAL SHOW POSTPONED. The seventh annual electrical show planned for Oct. 3, to Nov. 14 has been postponed. This action has been deemed advisable on account of unsettled conditions in the industry. The dates for holding the show have not as yet been set.

THE TRUMBULL ELECTRIC MFG. COA Plainville, Conn., has purchased machinery and patent rights covering the manufacture of armored cable, flexible conduit, and armored flexible cord. This material will be produced at the factory of the company located at Plainfield, Conn.

BOOK REVIEWS.

Handbook of Electrical Methods, published by McGraw-Hill Book Company, New York City, 278 pages. Many illustrations. Price $3.

This work is one peculiar in make-up, being a compilation of practical suggestions and methods from a large number of electrical men as published in past issues of the Electrical World. The subject matter has to do with practically no theoretical considerations but rather gives the practical ways that have been found satisfactory in handling electrical installation and operation. These suggestions and methods have been properly classified and arranged so as to cover a large range of electrical conditions. The book is divided into ten chapters, with the following headings: General notes; Line Construction and Equipment; Meters; Operation of and Changes in Circuits; Switchboard and Power House Details; Signs and Lighting Applications; Lamps and Lighting Circuits; Transformers, Oil Switches; Motors, Motor Switches and Generators.

To those who are keeping a file of clippings from electrical publications, this work will at once appeal and to those who have not establish this practice it will provide a means of securing such information from the Electrical World and emphasizes the value of a clipping file for all technical publications.

SWITCHBOARDS, SWITCHING AND PROTECTIVE APPARATUS by C. C. Adams, B. S. Published by American School of Correspondence, Chicago, Ill. Price $1.00.

This work takes up a practical discussion of switchboard equipment, wiring methods and safety devices to meet the requirements of direct and alternating current circuits. It is written by a switchboard engineer of the General Electric Company, a man of experience in the design of such apparatus for requirements in central station power and lighting plants, as well as industrial and private plants. While the book contains only 110 pages, the practical details are adequately covered and every electrical man having to do with the installation and operation of power plant equipment will find its value much in excess of the price.

TELEPHONE CONSTRUCTION, INSTALLATION, WIRING, OPERATION AND MAINTENANCE. By W. H. Radcliffe and H. C. Cushing. 180 pages, 125 illustrations. Pric.e—$1.00. This book gives the principles of construction and operation of both the Bell and Independent instruments; approved methods of installing and wiring them; the means of protecting them from lighting and abnormal currents; their connection together for operation as series or bridging stations; and rules for their inspection and maintenance. Line wiring and the wiring and operation of special telephone systems are also treated.

HEAT. By E. M. Shealy, University of Wisconsin. Published by McGraw-Hill Book Company, New York City. 257 pages. Price $2.00.

This work is one of an engineering education series prepared for use in the extension division of the University of Wisconsin. Fundamental laws relating to nature, generation, transfer and transformation of heat with examples are taken up in the first part of the text, as well as nature and properties of steam, ammonia, carbon dioxide and sulphur dioxide, the expansion and compression of same. In the last part of the book, the steam engine, gas engine, refrigerating machine and air compressor are treated. The work will interest engineers and firemen who have had experience with heat using machinery and desire a book taking up principles of operation.

ELECTRIC CAR MAINTENANCE. By Walter Jackson. Published by McGraw-Hill Book Company, 139 West 39th street, New York City. 270 pages. Price, $3.00.

The material in this work has been taken from the columns of the Electrical Railway Journal and arranged so as to make it a useful shop practice compilation of methods and data that will be decidedly useful to electric railway men. There are fourteen chapters with the following headings: Mechanical Appliances for Train Operation; Non-Electrical Parts of the Carbody; Brake Equipment and Brake Rigging; Trucks, Wheels and Axles; Cleansing by Dipping or Sand-Blasting, Car Washing, Painting and Glazing; Sanders and Sanding Devices; Scrapers and Brooms; Lubrication; Bearing Practice; Current-Collecting Devices; Motors and Gearing; Control, Circuit-Breakers, Controllers, Resistances and General Tests; Heating, Lighting, Signs and Signals; Welding, Shop Tools, Storage, etc.; Instruction Prints and Tables for Shopmen.

Many illustrations and working drawings are presented, and the methods described are such as require little costly apparatus.

ELEMENTARY MAGNETISM AND ELECTRICITY. By Cyril M. Jansky, Associate Professor of Electrical Engineering at University of Wisconsin. Published by McGraw-Hill Book Company, 229 West 39th street, New York. 206 pages. Price, $1.50.

This work has been prepared primarily for the use of electrical men who have some practical experience with electrical equipment, but a limited knowledge of engineering mathematics and theory. It is also adapted to the needs of students, the material on any subject being supplemented by experiments and practical examples. The work has been used in correspondence instruction by the extension division of the University of Wisconsin and found most practical. It is well illustrated and clearly written.

ELECTRIC TOY MAKING. By Prof. T. O'Conor Sloane. Published by Norman W. Henley Publishing Company, 132 Nassau street, New York City. 206 pages. Price, $1.00.

This work tells how to make electrical toys at home, such as motors, dynamos and instruments in general and is designed to bring within the reach of young and old the manufacture of genuine and useful electrical appliances. The work is especially designed for amateurs and young folks. Thousands of our young people are daily experimenting and busily engaged in making electrical toys and apparatus of various kinds. The present work is just what is wanted to give the much-needed information in a plain, practical manner, with illustrations to make easy the carrying out of the work.

ELECTRIC MOTORS—Their action, control and application, by Francis B. Crocker and Morton Arendt. Second edition revised and enlarged. 300 pages. Price $2.50. Published by D. Van Norstrand Co., New York.

The first edition of this work was published in 1910 and took up the design and construction of motors from the standpoint of operation. While the material was based upon lectures on motors and their application, given at Columbia University, the authors discussed motor operation in such a practical way that the book was at once recognized as something more than a mere text book of theory, and consequently has had a large sale among engineers and operators of electrical apparatus. The new edition has carried out the original idea still further and the volume in its present form is one of the most valuable of handbooks yet published on the subject. It contains much new and useful information on starting box calculations for direct and alternating current motors as well as a thorough discussion on power requirements of various tools.

FURNACE EFFICIENCY, by James Peebles. Published by J. G. Branch Publishing Co., Chicago, Ill. 148 pages; Price $1.00.

This is a small volume that discusses largely devices now on the market and designed to secure greater economy from burning coal in power plant furnaces.

HOW TO MAKE A TRANSFORMER FOR LOW PRESSURES, by Prof. F. E. Austin. Price 75 cents.

While this small book contains only 14 pages, the material presented gives in detail the necessary instructions and calculations to build a transformer at small cost. The book can be secured by writing the author at 11 South Park, Hanover, N. H.

ELECTRICIAN'S WIRING MANUAL, by Frank F. Sengstock, Electrical Inspector Chicago Board of Fire Underwriters. Published by Popular Electricity Publishing Co., Chicago, Ill. 400 illustrations. Price $1.50.

This volume contains well arranged, practical information and data referring to light, power and wireless installations. The information has to do almost entirely with interior work. The discussion on estimating is well presented and alone is worth the price of the entire work to electrical contractors and those of little experience in cost of standard construction requirements.

HOW TO BUILD UP FURNACE EFFICIENCY. By Jos. W. Hays, combustion engineer. Published by himself at Rogers Park, Chicago, Ill. 126 pages. Price, $1.00 with paper cover.

The best short description of this work could be aptly expressed by the one statement that it is a most delightful presentation of the horse sense necessary to operate a boiler. The writer possesses a breezy style, and whether you are the man who buys the coal and pays the men who use it, or the man who fires the coal and wastes it, you will not mistake when the author is talking to you and when to the other fellow. If any man can read this book and feel, when he has finished it, that he has learned nothing, then he had better do as the author advises—namely, tie a can to himself and ask someone to send him south of the Rio Grande, into the "manana country," to herd with the Greasers. It would pay every manager of a works where coal is burned a handsome profit to secure a copy of this book, read it himself, and then hand it to the boiler room foreman. If it does not cause him to sit up and take notice, then it's a sure sign that something is wrong in the boiler room, and the first thing to do is to fire this boiler room foreman and treat the new ones in the same way until one is found that makes the pages of this book so dirty that the print cannot be read. Such a man has the stuff in him that will cause him to burn coal and make steam at the least possible cost—and for this you will be out just $1.00, the price of the book. D. H. B

ELECTRIC LIGHT ACCOUNTS AND THEIR SIGNIFICANCE, by H. M. Edwards. Published by McGraw-Hill Book Company, New York. Leather binding. 155 pages. Price $2.00.

This work is written by one who for a number of years has held the position of auditor of the New York Edison Company and served on the accounting committee of the National Electric Light association. The material does not deal especially with the details of the system followed by the New York Edison Company but takes up the entire subject of central station accounting in such a way as to explain in considerable detail the essential features of accounting essential to the business of generating and selling light and power.

AN EXPENSIVE EXPERIMENT, by Reginald Pelham Bolton. Published by the Baker and Taylor Company, New York. Price $2.00.

Everyone interested in the progress of public utilities has probably heard or read during the past two years some glaring statements of the accomplishments of government speculation in the waterpower business in Canada, such stateement in most cases being seemingly clothed with authority. We have quoted such statements in these columns and in this issue will be found some interesting comment on them. The subject is one on which thinking engineers have been glad to get all possible information and the work mentioned here is one that cannot be ignored, first on account of its nature and second on account of the significant data presented.

In a book of some 280 pages, Mr. Bolton gives a sane presentation of the conditions under which the Hydroelectric Power Commission of Ontario was born and the ideas of those responsible for its creation. He explains what the commission has tried to do and what it has actually done, why it has not done what in many cases has been claimed and the results of its competition with existing utilities. Last and most important he shows the way out of the tangle, for indeed he shows it as such. Mr. Bolton is a man, who on account of years of engineering practice and study of financial and economic questions, is capable of viewing the conditions in Canada in the proper way and in giving his interpretation of these conditions has fortified himself with a mass of data from official publications that makes his statements non-refutable. He makes it plain that governmental speculation and competition in the electrical industry by which the money of citizens and taxpayers is expended, is in the main an ill-considered and ill-informed scheme formulated by radical and interested politicians under the guise of advocates of conservation.

This is a book that should be in the hands of every central station man selling electric service and such aone can do every customer and citizen a good service in the conservation of his income by putting this book into his hands. D. H. B.

THE SIMPLEX MANUAL. Published by Simplex Wire and Cable Co., Boston, Mass.

The 1914 edition of the Simplex Manual has appeared greatly enlarged and containing much new information and additional tables of use and value for electrical workers. A copy is furnished to those interested without charge.

HANDBOOK ON NATIONAL METAL MOLDING. This is the title of a 96-page booklet just issued by the National Metal Molding Company, of Pittsburgh, Pa., listing and describing metal molding fittings, their assembly and installation. The book has been prepared for the man on the job and furnishes such information as will enable him to make the best possible use of metal molding. In addition to the information on fittings, numerous installation suggestions are given together with pictures of installations showing a wide range of application. Every electric contractor should have a copy and can secure same without charge by addressing the company.

REPORT OF TRANSIT COMMISSIONER, CITY OF PHILADELPHIA. By A. Merritt Taylor, Transit Commissioner with Ford Bacon and Davis, consulting engineers. In two volumes with 69 maps and plans.

This work presents a complete and exhaustive investigation of ties in Philadelphia, including a system of subway and elevated railroads. An important feature of the work is the fund of information presented in maps and plans covering not only Philadelphia but such cities as New York, Chicago and Boston.

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Lighting Legislation for Visual Safety.

In considering the various elements of factory and work-room illumination, and the disregard frequently found for the features that govern the proper arrangements both for daylight and artificial light, the importance of correct and adequate legislative action for the uniform regulation of such installations is apparent. The illumination values of daylight are frequently in excess of that which can be used in comfort for working purposes, and often with no means provided for its correction; on the other hand, artificial lighting conditions and capacities are found in varying contrast, economical reasons sometimes reducing to a minimum the lighting values actually required.

Just as there has come a requirement for efficient public utility jurisdiction, specific laws are now needed to control the general phases of industrial lighting—laws that will establish proper and approved standards of practice for visual safety and tend towards wide betterment and individual welfare in industrial occupations. That no important step has been yet made in this direction is emphasized by F. Laurent Godinez, a lighting specialist, in a recent address before the Hudson County (New Jersey) Medical Society, when he showed that of eleven states now mentioning this subject in their general factory and labor laws, none carry any specific provisions to render such clauses of practical value.

The state of Connecticut provides that factories be well lighted, and that colored and corrugated windows may be removed if found injurious to the eyes. Illinois requires halls, stairways, etc., to have lights burning whenever the building is in service. Maryland stipulates that factories be well and sufficiently lighted, and Michigan requires foundries to be well lighted throughout working hours, with further provision that grinding and polishing cannot be done in basements unless sufficient light, heat and ventilation are evidenced, and such as may be prescribed by the factory inspector. In Ohio, Missouri, New Jersey and Rhode Island the Commissioner of Labor or inspector is authorized to give notice of alterations necessary where lighting, heating, ventilating or sanitary arrangements are considered dangerous to health. New York and Oklahoma require work-rooms, halls and stairways leading to them to be properly lighted, and Pennsylvania, with similar requirements, has additional provisions giving the inspector power to direct alterations where lighting arrangement is not sufficient. A more positive stipulation in these laws would bring more positive and noticeable results. Generalities have no place in such regulations, and should be superseded by specific requirements, and all authorized provisions rigidly enforced.

In regard to visual safety and what constitutes such, a statement by Dr. Ellice M. Alger, the well-known opthalmogist, that the general impression that a room which is best lighted is most lighted is a great mistake, supports the contention that the eye accustomed to a mellow, yellow light at night is often subjected to too startling a contrast in changing to a glaring white light, which accordingly exceeds a limit of safety. Too intense light, Dr. Alger maintains, decomposes the visual purple of the retina faster than it can be replaced, and leaves a condition of retinal exhaustion. Likewise, it may be said to compel a constant extreme muscular contraction of the pupil in an effort to exclude light, which is both fatiguing and painful.

Lighting specialists have agreed that the values of from 0.1 to 5 candle power per square inch constitute the minimum and maximum range of safety for the eye, and by the following table Mr. Godinez shows the comparison of various lights with relation to their visual safety:

Source of Light.	Candle Power Per Sq. Inch.
Candle	3- 4
Oil Lamp	3- 8
Gas Flame	3- 8
Gas Mantle	20- 50
Electric Lamp (Carbon Filament)	375- 400
Electric Lamp (Tungsten Filament)	1,000-1,500

Safe limit of brightness for the eye...............5

The increase in source of brilliancy up to the present day and the advent of the perfected high-powered electric light have been gradual, with an excess in safety limit according to scientific tests and deductions of 200, under customary conditions, as noted in the maximum of the above table. The frosting of lamps diminishes the glare without any material waste of useful light or shortening of the burning life, and should be strongly recommended, as it affords great relief to the eye. As to lighting arrangement, direct glare should be eliminated as far as possible with a consideration of greatest efficiency and economy and observance of physiological laws. Interest has, fortunately, turned in this direction very recently, and if all who have occasion to specify and install lighting equipment are carefully watching the trend of affairs in standards of good lighting, it is certain a most interesting evolution is to take place. This is a matter in which all who read should be interested.

The War and Central Station Industry.

With three months of modern warfare in Europe now becoming history, those who have made a study of the effects of the conflict on American industries begin to talk in a somewhat less speculative tone. As regards the central station industry, we quote a most optimistic comment by no less authority than Secretary T. C. Martin of the National Electric Light Association, in the association's official organ. He says:

"On the whole, widespread inquiry would indicate that the central station has been holding its own remarkably, even gaining a percentage. After all, this is what we are entitled to expect, for while any reasonable and wholesome reduction of operating expenses can be readily put in force, the wonderful diversity factor of our industry and the great opportunities still lying before it at the other end of the sales spectrum, of delivering great quantities of energy in bulk, place us as an industry in a position of exceptional advantage. The one serious "crimp" put into us is the difficulty in securing new capital for extensions; but we are not to blame if the destructive instead of the constructive forces of the world are momentarily in the ascendant. It is for us to be conservative, patient, but courageous. We are of the future much more than of the past and the future is with us. The one main, great thing is to maintain efficiency and serve the public better than ever.

"The unparalleled situation develops or reveals the fact as to our extraordinarily slight dependence as an industry on foreign supplies. Some of the goods we secured were of high quality, and we would still be glad to have them, but the business goes along without them, and manufacturers here will be spurred on to replace them, if not obtainable from abroad. Our electrical export trade is likely to be much larger than ever, for in markets involved in war we sold very little, and all the neutral markets are more than ever subject to our ability and enterprise.

"An export trade which reached barely 10 per cent of the estimated and authentic output of electrical goods in this country of $250,000,000 should at least be doubled; and with such larger output of domestic goods there should assumably go a reduction in price all around to consumers in this country, central stations being in the front rank of buyers of all such material, apparatus and supplies. The development of such a situation under unprecedented conditions will certainly be watched with the keenest interest by us all. Meantime we shall all hope, wish and pray for the return of world peace."

Another view of the situation, namely from the extension and new construction viewpoint, was ably summed up by Mr. Charles W. Black, president of the American Electric Railway Association, in his address at the Atlantic City convention early last month. Mr. Black said:

"The European war has, of course, very largely increased the difficulties of securing fresh capital, as is vividly illustrated by the fact that the City of New York recently was obliged to pay 6 per cent for money obtained on notes exempt from many forms of taxation and to run for from one to three years.

"We are still a debtor nation. If there was any doubt upon this subject, it surely has been dispelled by the recent course of exchange on London. The money centers of Europe have in the past absorbed vast quantities of our public service securities, but these markets have now been absolutely cut off, and it is hardly probable that they will again be available for a long time to come. This means that we must depend on American capital for future development, but it will take more than the possibility of an 8 per cent return to secure this capital, especially under the conditions of junior financing, which must be resorted to in many instances. Our task is to convince the public and the commissions that these are real facts, not theories, and that, until they are recognized, no further development is possible."

The total mileage of street car lines in the United Kingdom, with its population of 45,000,000, is equal to approximately the mileage of the State of New York or Pennsylvania (not both, but one of these states), with population of 9,113,000 and 7,665,000, respectively. From the top of any of the high buildings in New York an observer may cast his eye over an area lying almost at his feet (Manhattan, Brooklyn, Westchester, and the New Jersey suburbs), with a population of 6,500,000, that is served by 50 per cent more unit electric cars than are to be found in the whole of the United Kingdom.

Rebuilding of Hot Springs Ark., Light And Railway Property

BY S. F. ALLEN, OF GAUTHIER, ALLEN & JONES, ENGINEERS, MINNEAPOLIS, MINN., FORMERLY ELECTRICAL ENGINEER OF FEDERAL LIGHT AND TRACTION CO.

Section 1. Methods Used to Restore Service in Hot Springs (Ark.) After Complete Destruction of Plant by Fire.

WHEN fire swept Hot Springs, Ark., on the evening of September 5th, 1913, destroying forty city blocks with an estimated loss of $5,500,000, the generating plant and offices of the Citizens Electric Company were wrecked. The Federal Light & Traction Co., of New York controls and operates the public utility companies of Hot Springs which consist of the Citizens Electric Company, the Consumers Gas Company, the Hot Springs Water Company and the Hot Springs Street Railway Company. The Citizens Electric Company furnishes all the electric light, power and commercial service in the city, and power to the street car company. In the fire, the generating station and offices of the company, also the distribution system in the fire swept district were entirely destroyed. The street railway company suffered materially through the loss of overhead construction, in having ten blocks of its trolley system destroyed or badly damaged, but no street cars were damaged owing to the fact that the car barns were located away from the burned district.

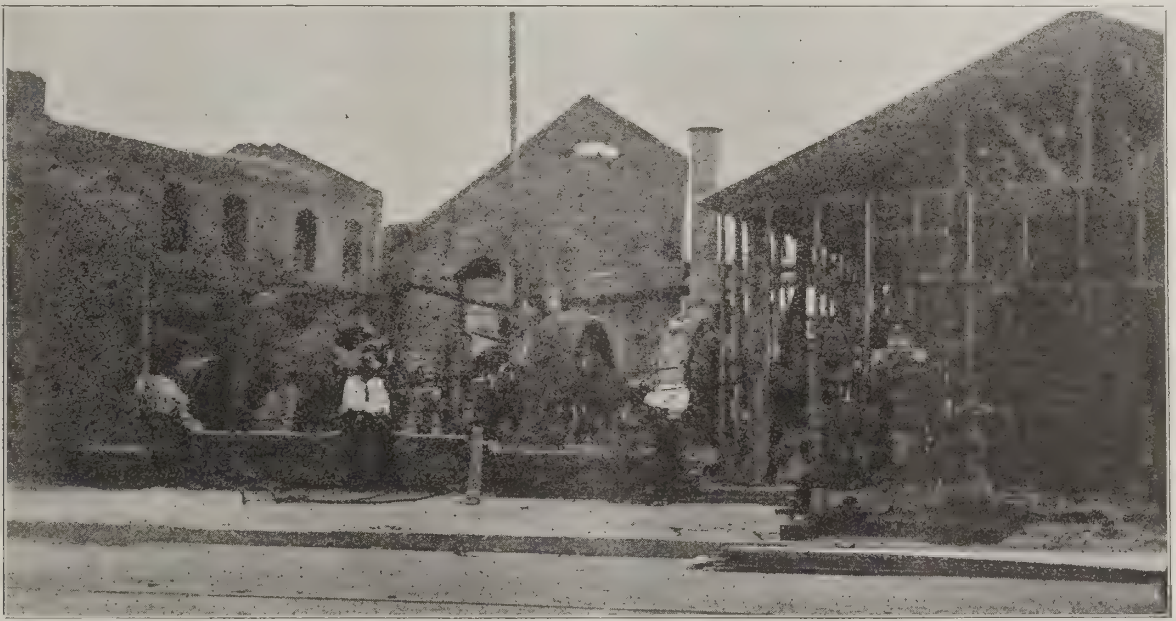


Fig. 1. Ruins of Engine Room at Hot Springs, Ark., and Temporary Structure to Restore Service.

RESTORING SERVICE

At the time of the fire, the Federal Light & Traction Co. was extensively engaged on some reconstruction work at their Southwestern properties, and had an efficient engineering and construction organization which was called upon to take care of the work of rebuilding the property under the personal supervision of Mr. W. A. Haller, general superintendent and chief engineer. Great credit is due him as well as the Federal Light & Traction Co's officials and the local management for the quick action taken to relieve the crippled property.

As soon as word was received in New York that the plant of the Citizens Electric Co. was destroyed, W. A. Haller started South and while enroute to Hot Springs, Ark., notified the heads and foremen of the construction organizations scattered in Colorado and New Mexico, to report at once in Hot Springs, so that within forty-eight hours after the fire a full force of well organized workmen under the head of competent engineers and foremen were busy clearing away the debris from the car tracks, overhead and distribution lines and the power house ruins so as to ascertain how badly the power house and other equipment had suffered from the havoc brought on by the fire. As soon as gangs of men had cleared away the street car tracks, horses and mules were hired and hitched to the old lightweight street cars which had been kept in the car barns as relics of old days and were not too heavy for them to pull. As the company had only a few light-weight cars that could be drawn by horses or mules, Mr. S. E. Dillon, the Gen. Mgr., put into service, automobiles, delivery carts, tally-hos, buggies and anything that people could ride in. The mule drawn street cars attracted considerable attention and recalled the first days of the coming of the street railway but the company won additional friends by its splendid efforts to give people an opportunity to reach the center of the city from the outlying districts. The fare remained at five cents though it cost the company much more to haul the passengers.

While engineers were busy checking up the extent of the damaged over-head and distributing lines, transformers, meters, etc., estimates were being prepared covering the work of rehabilitating the property and rush orders were sent out to the nearest supply houses to express from the nearest stock the necessary over-head line material that was needed to start the rebuilding of the feeder system and keep busy a large force of linemen that had already started the work of digging holes to replace the poles damaged or burned during the conflagration.

Large crews of linemen were put to work night and day cleaning up the fire district, and one of the first steps taken by the company to relieve the lighting situation in the business and congested districts was to put a crew of linemen connecting up some old railway feeders to some of the local isolated plants in the city so as to permit feeding a part of the business district and hotels and relieve temporarily the lighting situation. As a precaution the company detailed a man to see that no one of the fortunates, having electric light from this source, would turn on more lights than was absolutely necessary

Practically all of the electric elevator service, which was 500 volt D. C. before the fire, was out of commission, and many of the patients who were taking the baths at the Springs depended almost entirely on this elevator service in their hotels. To relieve this situation, one of the boilers at the burned power house was put into shape, the piping repaired and gone over. This boiler was put in operation under reduced pressure so as to furnish steam for a 35 K. W. direct connected exciter unit which was expressed from the Springfield, Mo., property. A 500 volt motor was secured locally and belted to the fly-wheel of this steam driven exciter set and used as a 500 volt generator to supply elevator service and relieve somewhat, the elevator situation in the hotels.

The power plant and office building constructed of brick and wood with tar and gravel roofing, was an easy prey for the flames. It was practically a complete loss after the fire had once swept through the buildings. The boiler room equipment which consisted of Sterling boilers equipped with Jones underfeed stokers, boiler feed pumps, heaters, etc., was under a large mass of debris after the roof structure had fallen in. Two of the steel stacks, the breechings and most of the high pressure and feed water piping were down and covered with burned material, however 5—250 horsepower boilers were worth overhauling.

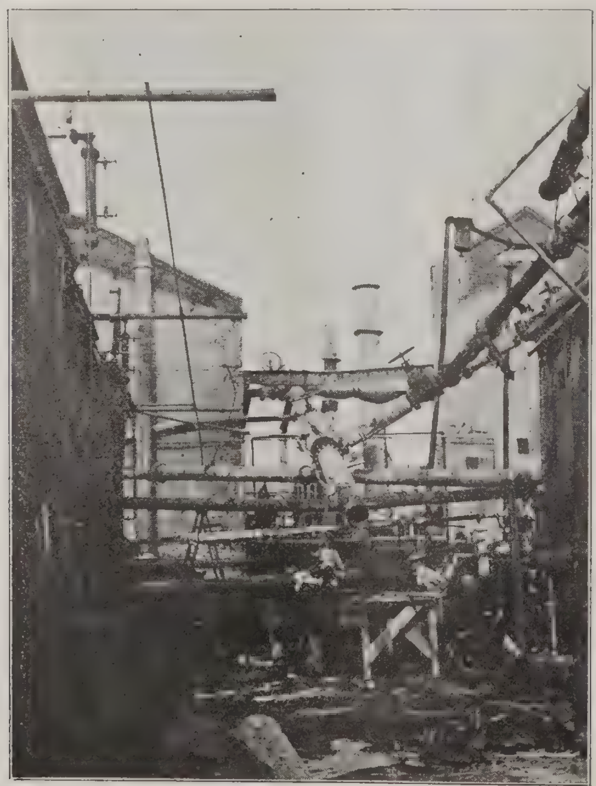


Fig. 2. Destruction in Boiler Room of Station.

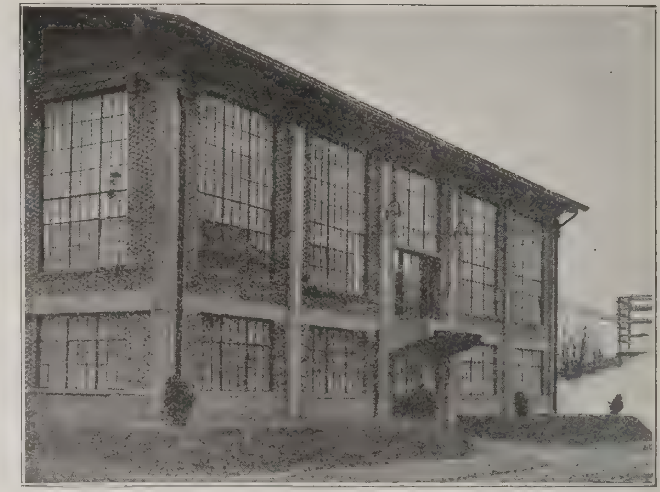


Fig. 3. Engine Room Side of New Station Showing Junction Tower for Outgoing Lines in Rear.

A thorough and careful examination of the power house ruins revealed the fact that all machines were burned so that only a 1250 Kw. General Electric turbo-generator and a small Bullock exciter set was worth repairing. The frames of the motor generators, reciprocating engine turbine units and rotaries were so warped and cracked from the intense heat that it was out of the question to repair or rewind any of the equipment with the exception of the 1250 Kw. turbo-generating unit mentioned, so that the balance was junked.

This 1250 Kw. turbo-generator saved, exhausted into a No. 13 Westinghouse Leblanc condensing equipment which, being located in the engine room basement, suffered least from the fire although badly damaged. Work of putting it into shape was immediately started. All the small mechanism and operating levers on the turbine were burned off or broken when the roof fell in, but the bearings were intact except the babbitt in the outboard generator bearing which was melted out. The fire had swept through the armature coils which were so badly damaged that the armature had to be rewound. Winding materials for the generator and extra parts for the steam end of the turbine were expressed from Schenectady, and as soon as the material was received, three crews of winders on an eight hour shift were put to work night and day so as to permit armature rewinding work in record time. The damaged parts of the generator field were also repaired while the rewinding of the armature was in progress. As the oil was burned in the oil piping and chambers, all the oil piping was replaced, the oil chambers thoroughly cleaned and temporary repair parts made locally to replace the burned mechanism. Springs were retempered on the job and used again.

The work of rewinding the armature of the 1250 Kw. turbine was completed in the afternoon of the 20th of September, and four hours after the job was finished, the field was replaced, the machine run up to speed and the generator dried out. Additional boilers were overhauled making three boilers ready to furnish steam for the turbine as soon as it was ready to be put into commission.

After the condensing equipment, which consisted of the condenser body and steam driven air and circulating pump had been uncovered from the debris, that had fallen into the basement, it was found to be the only equipment that did not suffer materially from the heat with the exception of the babbitted bearings, which were soon put into shape again. They were rebabbitted on the job, and after a cleaning up and a replacing of the air, pressure and vacuum gauges, the equipment was ready for operation.

A temporary frame building covered with corrugated galvanized iron was erected over the turbine so as to permit rewinding operations during the bad rain which followed the fire, and was made large enough to later accommodate a new four panel switchboard, exciter set and a 300 Kw. motor generator set for railway service. This building was used as a temporary power house structure until such time as a new generating station, plans for which were already under way, would be ready for operation. Meantime, a four panel switchboard was expressed from the Albuquerke property, erected and connected in record time, as the old switchboard was a complete loss.

The overhead distribution system was in a tangled mess, but the work of rebuilding same was soon systematized, and a great deal of credit is due to the local force in getting it straightened out in short time without any mishap. Wires that were formerly secondaries were cleaned and changed to primaries, others that were 3-phase feeders were branched out and used as railway feeders. The whole distribution system was finally rebuilt for a three-phase power system and a 110-220 volt lighting system, but temporary lines were strung and made ready for distribution about the same time that the work of rewinding the armature of the turbo-generator was finished.

During the afternoon of September 20th, or exactly fifteen days after the fire destroyed the property, the 1250 Kw. turbine was ready for service, and with the distribution system put in shape the resumption of the lighting and commercial service was permitted, and the people of Hot Springs were thanking the company for their efforts in restoring service in spite of great handicaps. With the temporary power house in operation, steps were taken to prepare for the resumption of the street car service as soon as a motor generator set, which had been ordered from the General Electric Co., would arrive. On the afternoon of September 24th, this new 300 Kw. 2300-550 volt machine arrived in the Hot Springs railroad yards, located three blocks from the power house. A crew of experienced riggers were ready for the unloading and the machine was unloaded, brought up to the power house and connected up in the course of the night. The first car left the barn at 6 A. M. on the morning of the 25th, and electric street railway operation, which had been discontinued after the fire for lack of power, was resumed.

Electric street lighting was made possible the following night, after two C. I. S. C. arc light transformers had arrived in Hot Springs. These were shipped from some other property without any oil, but with the idea of re-establishing street lighting at the earliest possible moment, the transformers were connected without using the tanks and desk fans used to cool the transformers. A small steam driven Bullock exciter was thoroughly gone over, rebabbitted, rewound and made ready for operation so as to have an extra exciter set available for emergency.

The temporary work done to the equipment, overhead lines, etc., while done in record time, proved to be entirely satisfactory and no trouble whatsoever was experienced with it later. The repaired turbine operated continuously from September 20th to January 1st, 1914, at which time the new generating station, which has been built outside the city limits, was put in regular operation. Though the work of reconstruction was extremely hazardous, there were no accidents that entailed serious injury to the workmen or to the machinery, and the only delays experienced were in getting material for the work on hand.

Section 2 of this article will take up details of the new station constructed in record time.

A Practical Discussion of Induction Motor Characteristics

BY H. G. DAVIS, E.E.

IN the uses to which induction motors are subjected at the present time, the demands are various. On account of its nature, the induction motor is a constant speed machine and while simple in construction and completed form, its electrical characteristics are not thoroughly understood in most cases. This condition often leads to a wrong idea as to the size of motor to be used as well as to the uses to which a given motor can be subjected. A better understanding of the relation of the quantities of torque at starting, running torque, maximum or pull out torque, to efficiency and power factor as well as to the mechanical characteristics of the machine would lead to more satisfaction among the users of the machine, especially in cases where a competent engineer is not available to give advice in the selection of the motor. These points the writer will take up in this article and those that follow.

From the users point of view, the motor must give continuity of operation in its required cycle and must be able to stand a certain addition in load without overheating and must be able to stand certain variation in voltage without dropping out of step. There are, generally speaking, two general uses of the induction motor which require entirely different considerations. In one class of service, the motor starts under light load or under no load at all and after it has come up to speed the load is applied gradually until a value is reached which is steady for most of the time and which is exceeded for only short periods. This class of work will require a motor whose size can be determined so that it will be working at its best efficiency and power factor. Some motors for this class of service may drive line shafting and will perhaps have a heavy static load at starting. This will require a starting torque, perhaps double the required full load running torque of the motor. Under this condition, to limit the current at starting, a type of motor would be required perhaps with features for additional starting torque so that the current demand at starting would be limited. This additional starting torque for the current permissable, perhaps limited by the company supplying the power, can be obtained by additional resistance in the rotor. However, if this resistance is permanent, additional losses will be caused under the normal operation. Thus, for efficiency, this torque at starting should be obtained by an auxiliary feature which removes the resistance when the motor has reached full speed. Thus the motor can be designed for sufficient torque at full load and have the best permissable efficiency.

Under the second class of induction motors, we find those which are used where the torque varies and the motor is subjected to sudden increase in torque for short periods only. The period of load is thus fluctuating and the torque demands are very high. In this case high starting torque and high maximum output are required.

It can be seen that these two classes of use require different electrical characteristics and different mechanical features in motors. In considering the capital invested in relation to the cost of power to give satisfactory service, each installation would require consideration of detail peculiar to the individual service of the particular installation. A consideration of the electrical features of the induction motor will lead to a better understanding of the application to any particular service and to a better idea of what a given motor will do.

The induction motor is essentially a two-coil transformer. The voltage is impressed on one coil (the stationary winding) while induced current flows in the other coil (the revolving winding) or rotor of the machine. The tendency of the rotor to turn is produced by the reaction of the induced currents in the secondary or rotor winding upon the magnetism produced in the stator by the impressed voltage. This tendency to turn is the torque which is exerted on the pulley of the motor and is in turn the pull of the belt which transmits the power of the motor or the torque transmitted to the gear when the motor is geared. This torque is expressed in lbs. at one foot radius as the turning effect or moment which is exerted by a lever one foot long with the given number of lbs. on the end of the lever and acting at right angles to the lever. The reason for the turning of the rotor is that the field magnetism or the magnetism in the stator produced by the applied voltage revolves around the periphery of the stator or is, in other words, a revolving field. At any given point on the air gap, the field magnetic density will rise to a maximum in one direction and then decrease to zero again, rising to a maximum in the other direction. This cycle will be repeated as many times per second as the frequency of the impressed voltage. The time of the maximum values of magnetism for successive points on the air gap will differ, but successive points will reach their values in order so that the effect is that of a wave of magnetism going around the periphery. This revolving field of magnetism is produced in all polyphase motors so that the tendency to turn or the tendency of the armature coil to follow the wave ofmagnetism of the stator is always present. Thus the self starting properties of the polyphase induction motor are explained.

The single-phase induction motor does not have a revolving field but a pulsating field. Hence until the single phase motor starts, there is no torque exerted on the rotor and there is no tendency to turn. This is the greatest defect of the single-phase motor. Some kind of phase spliting device is usually adapted to give torque at starting. It is not customary to start a straight single-phase motor under load. The production of the revolving field of magnetism is due to the winding arrangement of the polyphase induction motor.

As stated above, the magnetism in the field of an induction motor at a given point will start from a given value and reach a maximum in one direction, then decrease to zero and rise to a maximum in the other direction, after which it will drop to zero and repeat the cycle. This cycle will be repeated as many times per second as there are cycles per second of the applied voltage. Thus the cycle of magnetism of any given point of the stator will be repeated 60 times per second for 60 cycle alternating current and 25 times per second for 25 cycle alternating current. Again the wave length of the magnetic wave is two poles, that is, the distance between points of equal magnetism in density and direction, is the distance covered by two poles. The sketch in Fig. 1 shows the meaning of this. The poles are shown in Fig. 1 as definite poles, while the poles of the induction motor are not mechanical projections as on a direct current machine but are formed magnetically by the arrangement of the winding. Since the time in seconds between successive maximum values in the same direction is (1.0 divided by the frequency) per second, and the wave length or distance between corresponding wave points is the distance across two poles, the speed of a point on the rotor or the time required to go from the center of one pole to the center of the next pole of the same polarity (a distance of two pole widths) is $(1 \div f)$ seconds where (f) is the frequency and the motor is running at synchronous speed or at the speed when the armature coil is following in synchronism with the wave of magnetism.

If the stator has two poles covering the whole periphery, the armature will make a complete revolution in $(1 \div f)$ seconds or (f) revolutions per second. For four poles the time required for a complete revolution will be $(2 \div f)$ seconds or the number of revolutions will be $(f \div 2)$. In general let (f) equal frequency of impressed voltage in cycles per second; (p) equal number of poles of stator. Then the time required to pass any two poles equals $(1 \div f)$ seconds, and the time required to pass the total number of poles or (p) is $(p \div 2f)$ seconds. Since the time to pass (p) poles is the time of one revolution, the number of revolutions per second is the reciprocal of the time of one revolution or $(2f \div p)$.

Since the speed of induction motors is given in revolutions per minute we have:

$$\text{Rpm.} = (60 \times 2f) \div p.$$

Thus we can determine one quantity when we know the other two. We may have a given frequency and desire a certain speed on the motor. From the above equation we can determine the number of poles. This equation refers to synchronous speed only. At no load the motor runs a fraction of one per cent below synchronism and as the load

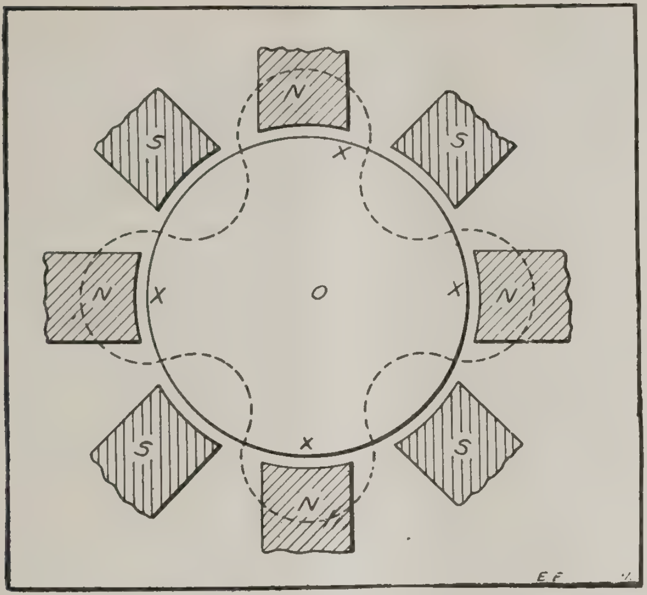


FIG. 1. SHOWING MAGNETIC POLES FORMED BY STATOR WINDING OF INDUCTION MOTOR.

is increased the motor lowers its speed somewhat. The amount of decrease in speed is called slip and is expressed in percent of synchronous speed as in the above equation.

Slip or the decrease in speed below synchronism expressed in per cent of synchronous speed is due to the necessity for torque in making the motor turn. As stated before, torque is the reaction of the rotor current on the field magnetism which revolves. The field magnetism for constant voltage on the machine is practically a constant so that to vary the torque, the current in the rotor has to vary. In order to do this the speed of the rotor relative to the revolving field (magnetic) must change for any desired change in torque. Thus as a load increases, the torque must increase and the rotor has to slip in speed so that a greater induced current flows in the rotor. At standstill, with voltage impressed on the stator, the greatest voltage is induced in the rotor bars and hence the greatest current will flow, assuming a squirrel cage rotor or a rotor in which the resistance remained unchanged on starting. Torque is produced to start the motor and the motor increases its speed until it reaches a speed within a fraction of one per cent of synchronous speed. If the motor was driven exactly at synchronous speed, the rotor bars would be travelling around the periphery at the same speed as the revolving magnetic field. Consequently the revolving field would not induce any voltage in the rotor and no current would flow in the rotor bars. Thus we see that the slip must be such that enough current flows in the rotor to produce the torque required to drive the motor and balance the torque required at the given speed and load. Without load the torque is that to balance friction and windage.

The electrical characteristics of the induction motor are determined from the resistance and reactance of the two windings together with the slip. For a complete mathematical discussion of the induction motor see (Steinmetz's A. C. Phenomena).

As stated above, at no load the motor will run practically at synchronism and the power consumed is that necessary to overcome friction and windage and supply the iron loss of the machine. If the machine were driven by another source of power by means of the pulley, the power input electrically to the stator would be only the core loss to the stator the same as in a transformer, plus a slight I^2R loss due ot the resistance of the winding and the current flowing. The current would be the magnetising current and the core loss current. Thus when the motor is running light, the current is core loss current, plus friction and windage current, plus magnetising current. As in a transformer, the magnetising current is watless. A wattmeter reading at this speed and under this condition would be the sum of the coreloss-watts, friction and windage watts and the watts due to the resistance in the primary winding. Since the machine is practically at synchronism, there will be very little current flowing in the rotor so that the resistance loss can be considered as that in the primary only.

To obtain the values of current and watts as stated above, the motor should be run at no load and rated voltage and frequency. Under this condition the motor will run almost at synchronism and the losses will be core loss, friction and windage, and the slight stator copper losses. Under this condition read watts, voltage and current. Reduce the voltage in steps and for each new value of volts read watts and current. For all readings, of course, the frequency must be held constant. As the voltage is reduced, the watts and current will both decrease. A point is reached finally where, for a slight reduction in voltage, the current begins to increase and the motor will fall out of step or drop below synchronism. It will be found that, at this point, the voltage is a small percent of normal voltage and consequently the coreloss will be negligible. The watts input represent the watts required to overcome friction and windage plus the slight copper loss in the stator windings. Thus we can subtract the copper loss in the stator windings for the value of current and obtain the friction and windage loss of the motor.

To obtain the resistance of the primary windings, direct current can be used. If the value of the direct current is (I) and the voltage drop is V, then the resistance between phases is (V ÷ I) equals (R) total. If the motor is Y connected (R) per phase equals (R) total divided by 2. If the motor is delta connected (R) per phase equals (R) total times three halves. For two-phase, the resistance between lines is the phase resistance.

The total loss in the primary winding for a given current is: For three-phase, 3 times phase current squared times the phase resistance. For two-phase, two times the phase current squared times the phase resistance. Thus for the readings taken on the motor as outlined above, we have watts loss in friction and windage and primary resistance per phase.

At no load normal volts we have: Watts read = (friction and windage watts) + (coreloss watts) + (watts lost due to the resistance of the primary).

We can now obtain the watts core loss at normal voltage. The current at normal voltage no load, equals magnetizing current plus core loss current plus the friction and windage current added vectorially. The current to supply core loss and friction and windage is in phase with the voltage while the magnetizing current is wattless.

Let (E) equal the voltage per phase of the motor, then the value of (E) equals the impressed volts divided by 1.73 for a Y-connected motor and equals the impressed volts for a delta connected and two-phase motor. Let (p) equal the number of phases, then:

Core loss current per phase = (Watts core loss) ÷ (p × E).

Friction and windage current per phase = (Watts F & W) ÷ (p × E).

The no load current per phase equals $\sqrt{[I^2 mag. + (Icl. + I_2 f\&w)]}$ where the values of (I) as given are phase values. The no load current as read is total current. The value of no load current per phase is the value as read divided by 1.73 for a delta connected motor and as read for the Y connected and the two-phase motor.

From the total no load current as found per phase and the core loss and friction and windage current per phase, we can determine the magnetizing current per phase. It will be noted that all values of losses, current and voltage are given in terms per phase. We now have: No load current per phase; friction and windage watts per phase; core loss watts per phase; friction and windage current per phase; core loss current per phase; magnetizing current per phase; motor resistance per phase of the stator.

To obtain the remaining constants of the motor, a test must be made at standstill. These constants are (r_1) or resistance per phase of the secondary winding (x_0) or reactance per phase of the primary winding, and (x_1) or the reactance per phase of the secondary winding. If the motor has a wound rotor secondary, the resistance per phase can be measured by the same method given for the primary. If the motor has a squirrel cage winding then some other method must be used. One method is to block the rotor so that it cannot move and then put any given current through the motor stator. Read current volts and watts input. Under this condition the watts read are considered to be the I^2R losses in the stator and rotor for the given current.

Test calculations will be taken up in the next section of this article.

Some Cost Data On Small Out-Door Sub-Stations

BY H. W. YOUNG.

It is now generally recognized that the important problems involved in serving large sparcely settled districts from transmission systems, is one of economy. It involves not especially features of transmission or distribution engineering but the design, selection and installation of such apparatus that the cost of same will permit the taking on of loads around and less than 150 Kw at a reasonable profit. Transmission companies of the South and other sections are now installing to meet these conditions, comparatively small capacity sub-stations and supplying small demands at various points directly from main high tension feeders. To reduce the installation and maintenance costs, these sub-stations are as far as possible of standard designs. As to mechanical features, the tendency is to use steel towers whenever possible, however wood pole structures are considered good and installed where conditions demand strict economy. In any case all steel and malleable iron parts of outdoor sub-stations are now usually used hot galvanized since this process prevents rusting and makes possible a longer life than it is possible to secure from plain black or painted material. Actual experience has demonstrated that it is difficult to paint every part of a high tension tower so thoroughly that the exposed parts will not rust, especially at points of contact or where angles cross. Again if painted equipment is used, it must be painted often and in order to paint those parts at the top of the station, it is necessary to discontinue service or endanger the workmen.

In what follows some features of out-door sub-station design taking up standardization details and costs are presented as given in a paper read before the recent convention of the Indiana Electric light Association by H. W. Young, electrical and designing engineer of the Delta Star Electric Company of Chicago. In this discussion the author has used a transmission voltage of 33,000 as a basis for computing the costs in the tables and curves and makes the following recommendations:

For the large majority of installations, the local distribution can be accomplished by a 3-phase delta connected 2,200 volt system which has several advantages, such as permitting the use of standard 2,200 volt transformer at consumer's premises, freedom from short circuits in case of ground on one phase, etc. Again, in many cases, it will be found advisable to operate small power loads with two transformers connected in open delta, and for such installations the 2,200 volt delta distribution is advisable.

HIGH TENSION LINE COSTS.

In making up estimates for the installations of outdoor sub-stations, the cost of building a high tension line to cover a given area must always be considered. The net cost per mile of transmission systems varies over a wide range,

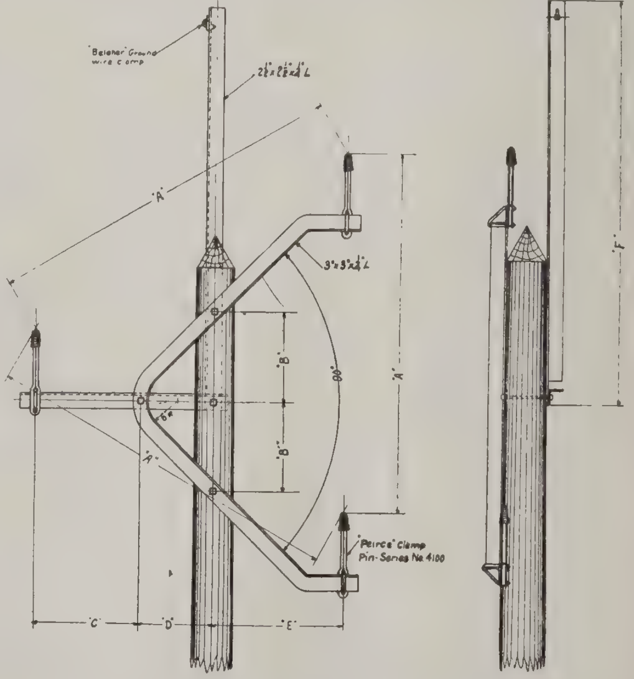

"Belcher" Ground wire clamp
2½"x2½"x¼" L
"A"
3"x3"x¼" L
"B"
"B"
90°
6"
"A"
"A"
"Peirce" Clamp Pin-Series No. 4100
"C"
"D"
"E"
"F"

FIG. 1. A DESIGN OF CROSS ARMS FOR 33,000 VOLTS, WITH A = 36 IN.; B = 12 5/16 IN.; C = 6 IN.; D = 12 IN.; E = 13.5 IN.; F = 50 IN.

SIZE OF LINE —— APPROXIMATE NET COST PER MILE OF MATERIAL AND LABOR ——

Conductors	Size of Poles	Poles and Cross Arms	Insulators and Pins	Ground Wire and Bayonets	Copper Wire	Telephone Line No. 10 Copper Clad	Labor and Supervision	TOTAL COST PER MILE OF LINE
No. 0	35′ 7″	42—35′ 7″ @ $8.70 ea. 4—40′ 7″ @ 11.00 ea. 2—45′ 7″ @ 13.30 ea. 48—Arms @ 1.33 ea. Total Cost=$499.84	150 Insulators @ $.45 ea. 48 (set of 3) clamp pins @ $.55 ea. Total Cost=$93.90	5800 ft. ⅜″ ground and guy wires @ $11.50 per M 48 Bayonets @ .57 ea. Total Cost=$94.06	5400 lbs. @ $.16 lb. 75 lbs. No. 4 tie @ $.16 lb. Total Cost=$876.00	320 lbs. @ $.15½ lb. 48 brackets .10½ ea. 96 insulators @ $.04½ ea. 96 lags.(½″x6″)@ .03½ea Total Cost=$62.32	Labor, teaming Supervision $450.00	Poles and arms.. .. $499.84 Insulators and pins. 93.90 Ground wire & bayonets. 94.06 Conductors and ties. .. 876.00 Telephone Line. 62.32 Labor and Superv 450.00 Total Cost... ... $2076.12
No. 2	35′ 7″	42—35′ 7″ @ $8.70 ea. 4—40′ 7″ @ 11.00 ea. 2—45′ 7″ @ 13.30 ea. 48—Arms @ 1.33 ea. Total Cost=$499.84	150 Insulators @ $.45 ea. 48 (set of 3) clamp pins @ $.55 ea. Total Cost=$93.90	5800 ft. ⅜″ ground and guy wires @ $11.50 per M 48 Bayonets @ .57 ea. Total Cost=$94.06	3500 lbs. @ $.16 lb. 75 lbs. No. 4 tie @ $.16 lb. Total Cost=$572.00	320 lbs. @ $.15½ lb. 48 brackets .10½ ea. 96 insulators @ $.04½ ea. 96 lags (½″x6″ @ .03½ ea. Total Cost=$62.32	Labor, teaming Supervision $425.00	Poles and arms... $499.84 Insulators and pins. . 93.90 Ground wire & bayonets. 94.06 Conductors and ties. . 572.00 Telephone Line....... 62.32 Labor and Superv.. .. 425.00 $1747.12
No. 0	30′ 7″	36—30′ 7″ @ $5.50 ea. 6—35′ 7″ @ 8.70 ea. 4—40′ 7″ @ 11.00 ea. 2—45′ 7″ @ 13.30 ea. 48—Arms @ 1.33 ea. Total Cost=$384.64	150 Insulators @ $.45 ea. 48 (set of 3) clamp pins @ $.55 ea. Total Cost=$93.90	5800 ft. ⅜″ ground and guy wires @ $11.50 per M 48 Bayonets @ .57 ea. Total Cost=$94.06	5400 lbs. @ $.16 lb. 75 lbs. No. 4 tie @ $.16 lb. Total Cost=$876.00	320 lbs. @ $.15½ lb. 48 brackets .10½ ea. 96 insulators @ $.04½ ea. 96 lags (½″x6″ @ .03½ ea. Total Cost=$62.32	Labor, teaming Supervision $425.00	Poles and arms ... $384.64 Insulators and pins. . . 93.90 Ground wire & bayonets. 94.06 Conductors and ties.... 876.00 Telephone Line.. .. 62.32 Labor and Superv . 425.00 $1935.92
No. 2	30′ 7″	36—30′ 7″ @ $5.50 ea. 6—35′ 7″ @ 8.70 ea. 4—40′ 7″ @ 11.00 ea. 2—45′ 7″ @ 13.30 ea. 48—Arms @ 1.33 ea. Total Cost=$384.64	150 Insulators @ $.45 ea. 48 (set of 3) clamp pins @ $.55 ea. Total Cost=$93.90	5800 ft. ⅜″ ground and guy wires @ $11.50 per M 48 Bayonets @ .57 ea. Total Cost=$94.06	3500 lbs. @ $.16 lb. 75 lbs. No. 4 tie @ $.16 lb. Total Cost=$572.00	320 lbs. @ $.15½ lb. 48 brackets .10½ ea. 96 insulators @ $.04½ ea. 96 lags(½″x6″)@.03½ ea. Total Cost=$62.32	Labor, teaming Supervision $400.00	Poles and arms..... . $384.64 Insulators and pins.. . 93.90 Ground wire & bayonets. 94.06 Conductors and ties... 572.00 Telephone Line... 62.32 Labor and Superv. 400.00 $1606.92

TRANSMISSION LINE COSTS FOR 3-PHASE, 33,000 VOLTS OPERATION USING TYPE OF POLE AND CROSS ARMS SHOWN IN FIG. 1.

depending upon local conditions, type of construction employed, etc. The amount of money to be spent on such systems depends largely upon the requirements to be met and whether the work is to be regarded as temporary or permanent. In many instances the tendency has been to adopt rather light construction which cannot be regarded as meeting modern requirements, such as reliability, continuity of service, and permanent work.

The costs given in the accompanying table are based on Northern Cedar poles (Chicago delivery) and the average prices quoted during August, 1914. Line costs are more or less variable, depending upon market and labor conditions, but the figures given can be safely used for estimating purposes. It will be noted that No. 10 copper-clad is specified for the telephone circuits, while many companies use No. 12 hard drawn copper. The No. 10 copper-clad is, however, stronger and will give better service than the smaller wire. Attention is called to the fact that the prices given do not include any percentage for store-room charges, incidentals, etc. There is always some miscellaneous material necessary for transmission lines, the cost of which actually enters into the total cost of the line. It is, therefore, good practice to add 5% to the material to cover incidentals.

OUTDOOR SUB-STATION COSTS.

When considering the use of outdoor sub-station equipment, one of the first questions to come up is—how much will it cost? As a ready reference in making up preliminary cost estimates, the values in tables 1, 2 and 3 can be safely used. These costs are based on normal prices quoted during August, 1914.

The data given in table 1, is graphically shown in curves A, B and C of Fig. 2. The data given in table 2 is graphically shown in curves D and E. A curve for table 3 would have the same general characteristics as curves D and E. The rapid decrease in cost per kilowatt with increased capacity of station is worthy of note. This indicates that the original installation should be such that as the load increases the station capacity can be increased at the least possible expense. With the standard control and protective equipment now available, it is only necessary to replace the original fuses with others of heavier rating, when increasing the station capacity.

TABLE 1. NET COST PER K. W. OF OUTDOOR 3-PHASE SUB-STATION EQUIPMENT.

Station Capacity	No. of Trans.	Transformer cost per K. W. 25 Cycles	Transformer cost per K. W. 60 Cycles	Cost per K. W. of High Tension Switching and Protective Units
45	3-15 K. W.....	$25.00	$20.00	$6.25
60	3-20 K. W.....	20.50	16.50	4.75
75	3-25 K. W.....	18.00	15.00	3.80
90	3-30 K. W.....	16.00	13.00	3.10
120	3-40 K. W.....	12.50	10.50	2.50
150	3-50 K. W.....	11.00	9.00	2.00

Net costs in Table 2 include all high tension bus bar supports, copper tube bus, high and low tension dead ends and a galvanized steel tower with footings.

TABLE 2. TOTAL NET COST OF STEEL TOWER 3-PHASE OUTDOOR SUB-STATION WITH 3 SINGLE PHASE 33,000/2,300 VOLT TRANSFORMERS.

Station Capacity	No. of Trans.	25 Cycle Station Per K. W.	Total Cost	60 Cycle Station Per K. W.	Total Cost
45	3-15 K. W.....	$35.50	$1,597.00	$30.25	$1,361.00
60	3-20 K. W.....	28.50	1,710.00	24.50	1,470.00
75	3-25 K. W.....	24.50	1,837.00	21.50	1,612.00
90	3-30 K. W.....	21.50	1,935.00	18.25	1,642.00
120	3-40 K. W.....	16.75	2,010.00	14.50	1,740.00
150	3-50 K. W.....	14.25	2,137.00	12.00	1,800.00

TABLE 3. TOTAL NET COST OF WOODEN POLE 3-PHASE OUTDOOR SUB-STATION, WITH 3 SINGLE PHASE 33,000/2,300 VOLT TRANSFORMERS.

Station Capacity	No. of Trans.	25 Cycle Station Per K. W.	Total Cost	60 Cycle Station Per K. W.	Total Cost
45	3-15 K. W.....	$34.25	$1,541.00	$29.35	$1,321.00
60	3-20 K. W.....	27.60	1,656.00	23.55	1,415.00
75	3-25 K. W.....	23.60	1,774.00	20.65	1,550.00
90	3-30 K. W.....	20.60	1,854.00	17.65	1,589.00
120	3-40 K. W.....	16.20	1,944.00	13.80	1,656.00
150	3-50 K. W.....	13.95	2,092.00	11.90	1,785.00

The costs in Table 3 are based on the use of four 35 foot, 8-inch top poles.

OPEN DELTA INSTALLATION.

When the original transformer installation consists of two units connected in open delta, the station capacity can be readily increased by adding a third unit of the same type and connecting in closed delta. Where three transformers were originally used, they can be removed and transformers of greater capacity installed—care being taken in the original installation to see that means are provided for readily removing and installing transformers.

LOCATION OF TRANSFORMERS.

Central station managers contemplating the use of outdoor sub-stations frequently request information as to whether the transformers should be located on or near the ground or at a point higher up. This question can be answered in several ways, as local conditions always govern. Fundamentally, the placing of transformers on platforms and considerable distance from the ground involves additional expense, especially for large size units. The sub-station supporting frames or towers must be heavier than if the transformers were on the ground, and in case of burn-out it is more difficult to remove or replace a damaged unit. However, by mounting transformers on a platform approximately 12 feet from the ground, certain advantages are gained. The high tension wiring can be kept up out of the way, fewer high tension bus supports are required and the general factor of safety is materially greater than with wiring near the ground. Another advantage secured by a platform mounting of approximately 12 feet, is that it gives sufficient space for a housing at the base of the sub-station. In this house can be placed all the secondary switches, meters, relays, street lighting regulators, spare parts, etc., thus securing a self-contained sub-station.

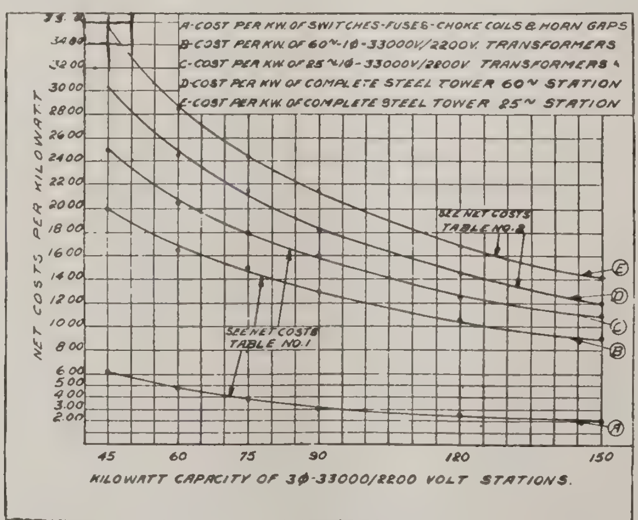


FIG. 2. COST CURVES FOR 3-PHASE 33,000 TO 2200 VOLT SUB- STATIONS.

In general, it will be found advantageous to place large transformers on or near the ground and mount transformers of 50 K. W. or less on a platform 10 or 12 feet above the ground. Provision can be readily made for conveniently and rapidly handling transformers so that in case of failure a defective unit may be quickly removed and replaced.

The Philadelphia Convention of Electrical Vehicle Association.

The fifth annual convention of the Philadelphia Electrical Vehicle Association was held at Philadelphia October 19th to 21. An interesting and complete program was arranged and a number of interesting papers presented, among which were the following:

"The Progress of the Electric Vehicle" by James H. McGraw of the McGraw Publishing Company; "Power Wagon Operation in Central Station Service" by W. A. Manwaring, superintendent of transportation Philadelphia Electric Company; "The Cost of Electrical Vehicles" by Geo. H. Kelley, secretary and sales manager of the Baker Motor Vehicle Company; "Electrical and Vehicle Performance," by Robert B. Grove, engineering department of the United Electric Light & Power Company; "A Practical Project to Secure Authentic Costs of Operating Commercial Electric Vehicles" by W. P. Kennedy, consulting engineer, New York City; "Electric Fire Apparatus," by Geo. S. Walker of Philadelphia Fire Department, Philadelphia, Pa.; "Educating the Public in the Field and Use of the Electrical Vehicle," by F C. Hendrochott, chairman of the committee on education of salesmen, National Electric Light Association; "Electrical Vehicle Charging," by T. F. Lincoln, president of the Lincoln Electric Company, Cleveland, Ohio; "Special Application of Electric Trucks," by F. Nelson Carle, advertising manager of the General Vehicle Company, New York City; "Effects from the Utilization of Kinetic Energy of an Electric Vehicle," by T. H. Schoept, engineer Westinghouse Electric Mfg. Co., Pittsburgh, Pa.; "A Wider Dissemination of Electric Vehicle Information," by T. I. Jones, manager of the commercial department of the Edison Illuminating Company, of Brooklyn, N. Y.; "Calculations of Electric Motor Characteristics and Particular Performance," by A. A. Nims, Crocker-Wheeler Co., Ampere, N. J.; Symposium of Electric Industrial Truck," by the electric vehicle manufacturing companies including General Vehicle Company, New York, Elwell-Parker Electric Company, Cleveland, Ohio, C. W. Hunt, New York City and Automatic Transmission Company, Buffalo; "European Development of the Electric Vehicle," by P. D. Wagoner, president of the General Vehicle Company, New York City; "The Design and Performance of Electric Vehicle Motors," by H. S. Baldwin, engineer of General Electric Company, West Lynn, Mass.; "Constant Potential Systems for Charging Motor Generators," by J H. Dodge, Toledo, Ohio.

Copies of these papers can be secured as well as other interesting information in connection with electric vehicle operation, from A. J. Marshall, treasurer and secretary of the Electric Vehicle Association, New York City.

The Calculation of Depreciation

BY GEORGE E. BARRETT, CONSULTING ENGINEER, PHILADELPHIA, PA.

ONE of the problems confronting the engineer in his investigations and reports, is depreciation, or the decrease in valuation of machines. Unfortunately this important consideration is generally neglected by the owners of the machinery until time brings them face to face with the renewal problems. This generally happens at a period when renewals are a serious problem, and owners are apt to put them off for what they consider to be, a more favorable time, which, however, from an economical standpoint, is decidedly wrong. As the valuation of apparatus decreases, its efficiency also decreases but not as rapidly, and the manufacturer finds that after a number of years of service his machine has not only decreased in valuation, but its output, or dividend paying means, is not as great in proportion to the input as in former years for it stands to reason that wear must increase its loss.

If a certain proportion of money were set aside yearly as a reserve fund for replenishing, when necessary, this perplexing problem would not be so serious, but unfortunately this is not usually done. The money is put in the business or goes to increase the profits. If put in the business it should be considered as a depreciation investment; the money used as a principal to bear interest, and a careful record kept, so that this amount will not be a loss for each succeeding year. In that way there is gained an increase in interest which the business pays over that obtained from a bank, with the depreciation reserve still under control.

The generally accepted method of allowing for depreciation, is to approximate the life of the machine, assume the current rate of interest, and set aside each year an amount, the aggregate of which with compound interest will equal its valuation. This does not include the losses from decreased mechanical efficiency, and therefore this amount should be increased each year so as to include this. This amount can only be arrived at by considering each individual case from practical data obtained from working conditions of each individual machine, or from similar machines under the same conditions.

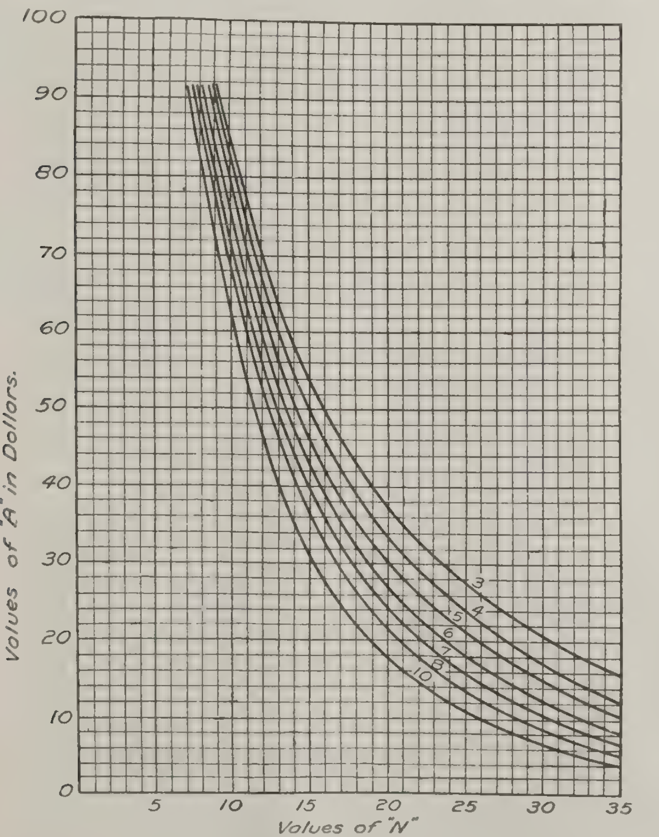


FIG. 1. DIAGRAM SHOWING RATE OF DEPRECIATION ON MACHINERY.

Let us assume, for an illustration, that a certain new machine when purchased, has a mechanical efficiency of 90% and at a time when it is advisable to replace it, its efficiency has decreased to 75%. If its output when new has a valuation of (A) dollars, its output has then decreased to 1/6 (A) dollars.

A carefully arranged method of depreciation will also give the manufacturer an excellent means of approximating the valuation of his machines at each inventory, which no doubt will prove of interest to him on numerous occasions. Neglecting the losses from decreased mechanical efficiency, the yearly rate to be set aside can be found from the following formula:

$$A = [100\, r] \div [(1 + r)^n - 1] \ldots\ldots\ldots\ldots (1)$$

In which A = amount to be set aside each year per hundred dollars; r = the allowable rate of interest as a decimal; and n = the number of useful years of the machine.

The useful life is approximately as given in the following table:

TABLE 1. USEFUL LIFE OF PLANT MACHINERY.

Name of Machine	Values of "N"
Boilers, fire tube	About 18 years
Boilers, water tube	About 25 years
Engines, slow speed	About 23 years
Engines, high speed	About 15 years
Turbines	About 20 years
Generators	From 25 to 30 years
Motors	From 18 to 22 years
Pumps	From 22 to 28 years
Condensers, jet	From 30 to 35 years
Condensers, surface	About 20 years
Feed Water Heaters	From 20 to 30 years
Economizers	About 20 years
Stokers	About 15 years
Ash and Coal Handling Apparatus	About 13 years
Piping	About 15 years
Wiring	About 20 years
Transformers	From 25 to 30 years
Storage Batteries	From 12 to 18 years

It will be observed that formula No. 1 has been arranged in Fig. 1 as a diagram for quick and accurate solution with the rates of interest from 3% to 10%. The values of (A) are given in $1000 valuations. For other values multiply (A) by the ratio. Thus, if the value of a generator is $5600, multiply the values obtained from the diagram for (A) by 5.6.

For example: What is the rate of depreciation on a machine whose purchase price was $3400.00, with a useful life of 20 years, and a rate of interest of 5%? From 20 on the bottom scale run vertically upward to the curve marked 5 then over horizontally to the vertical scale for A which gives $30.25 for one thousand dollars, therefore for $3400 we have $30.25 × 3.4 = $102.85.

While Table 1 gives the useful life of the apparatus, a manufacturer should renew long before that time arrives, as the efficiency would decrease to such an extent that his losses would be prohibitive, therefore it would be more practical to allow about 0.7 of the amount given in the table and base the depreciation allowance upon that.

Remote Control for Motor Driven Waterworks Pumps at Rock Hill, S. C.

BY J. G. BARNWELL, MANAGER AND CHIEF ENGINEER, PUBLIC WORKS COMMISSION.

In what follows the writer will describe a remote control system for operation of pumps at 550 volts, from a 11,000 volt transmission line. The layout of the equipment is shown in the accompanying diagram, Fig. 1, and the system in brief is made up as follows: The filtration plant for Rock Hill, S. C., is located in the city and connected to a raw water pumping station on the Catawba River, a distance of 30,000 feet, by a 11,000 volt transmission line. At the pumping station two motor driven pumps are installed, one arranged for local starting and the other for remote starting and control from the filtration plant. As shown in Fig. 1, a 11,000 volt oil circuit breaker at the filtration plant is arranged as a control switch to start and stop motor No. 2. At the river pumping station, a bank of transformers is connected in delta giving a secondary voltage of 550 and connecting to selector panels where the main circuit from transformers is divided into two separate 3-phase, 550-volt circuits, one going to the hand operated compensator of pump motor No. 1 and the other to an automatic starter and to pump motor No. 2. The details of these arrangements follow.

The city filtration plant of Rock Hill, S. C., already mentioned, has a capacity of 1,000,000 gallons of filtered water daily and is fed from a raw water pumping station on the Catawba River. This station is of reinforced concrete construction with arrangements so that this pump equipment is free from any damage that might result from high water, as well as providing uninterrupted service at such times.

The pumping equipment consists of two vertical 3-stage DeLaval turbine pumps, capable of delivering their capacity of 700 gallons per minute against a total head of 300 feet. These pumps are each direct connected to a 100 horsepower, 3-phase, 550 volt squirrel cage induction motor with a synchronism speed of 1200 revolutions per minute. The mechanical connection between pumps and motors is made by means of vertical steel shafts, supported at intervals by steady bearings arranged on iron truss work, which in turn are fastened into the main side walls of the buildings. The pumps are located 6 to 8 feet above the normal water level of the river, while the motors and control equipment are located above the pumps in a compartment above high water line. Pump and motor No. 1 are arranged with the standard General Electric hand starting compensator, the starter being located in convenient place in the motor room compartment, and can only be operated from that point. Pump and motor No. 2 are arranged for starting from the city filtration plant, which as before stated is 30,000 feet from the river pumping station.

The city plants are operated on a contract with The Southern Power Company to furnish their requirements on a meter basis. Power is delivered to the city transformer station at 11,000 volts, 3-phase, 60 cycles and stepped down to 2,300 volts for city lighting and power distribution.

The remote control, 3-phase circuit to Catawba River pumping station, which is discussed here, is however, taken direct from the mains of the Southern Power Company at 11,000 volts, after passing through protective circuit breakers, etc., and is delivered to one, 3-pole 15,000 volt, oil circuit breaker which is located inside the walls of the city filter plant and arranged for convenient handling from the filter plant operating platform. This circuit breaker is arranged with inverse time limit over load relays, so as to be operated from two 11,000 volt current transformers which are connected in circuit on the out-going 11,000 volt lines to the river station. The switch board panel for operation and control of above breaker is of black slate and carries the tripping coils with operating mechanism and is furnished with one low scale ammeter, an ammeter being also cut in on leads from current transformers.

The pole line connecting the plants is built of 30 foot chestnut poles spaced at intervals of 130 feet, and arranged to carry three power wires, one ground wire and two telephone wires. The three power wires are of No. 7 copper steel 47% conductivity, purchased from the Duplex Metal Co., Chester, Pa., and supported on 15,000 volt Thomas porcelain insulators, fastened on iron pins.

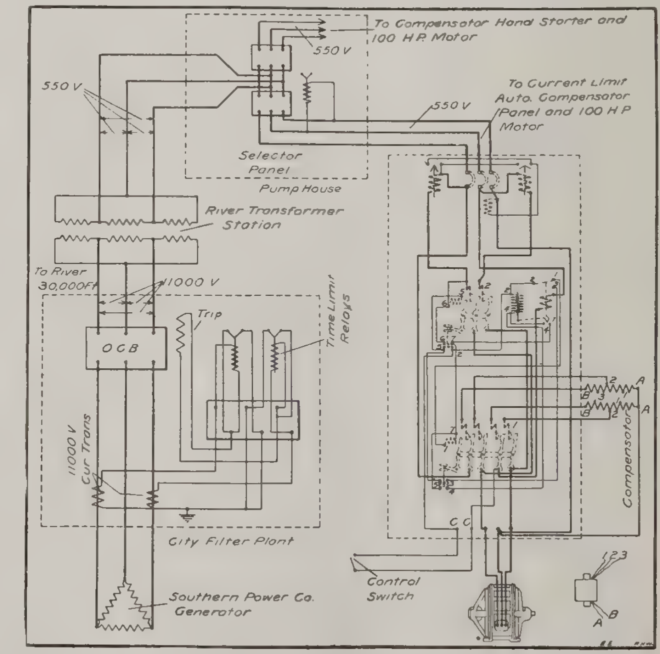


FIG. 1. LAYOUT OF REMOTE CONTROL SYSTEM FOR MOTOR DRIVEN PUMPS.

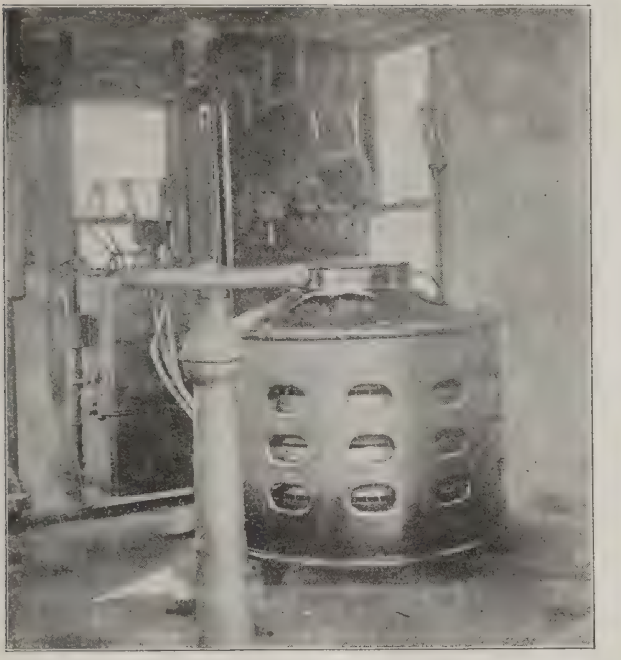


Fig. 2. Motor and Auto-Starter at River Station.

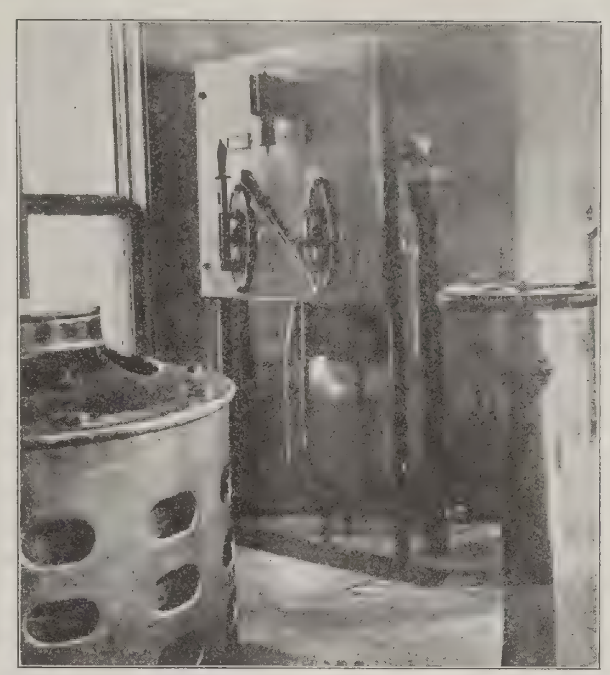


Fig. 3. Motor and Selector Panel at River Station.

The pins are of iron fastened through the cross arms with a nut, and held substantially in position. The ground wire is of No. 4 galvanized iron and is carried on a bayonet pipe attachment arranged at the top of the pole, the pipe being flattened at the two ends with the pole end arranged for the reception of ⅝-inch machine bolts, while the wire end is drilled for the reception of a Belcher clamp. The telephone wires are arranged on Pierce two wire galvanized iron brackets, fastened on the side of pole five feet below the power wires.

At the river pumping plant the voltage is stepped down from 11,000 to 550 volts by means of three 40 Kva. transformers delta connected. Incidentally it may be mentioned that there are no lightning arresters, fuses or choke coils in the leads to these transformers as they are connected direct to the line. The transformers were purchased out door type and are arranged on a concrete platform, same being fenced in by means of an 8 foot picket fence.

The 550 volt leads from these transformers are carried to the motor room compartment of the river pumping station, and there distributed by means of a selector panel into two, three-phase circuits, one for each pump. From this selector panel No. 1 set of leads is carried to the compensator of the hand started motor, while No. 2 set of leads is carried to a G. E. No. 126 automatic auto-starter, and from this starter leads are direct connected to motor No. 2. The connections are shown in Fig. 1. The 550 volt control circuit of automatic auto-starter is carried to a time limit relay which is mounted on a selector panel above the control switches. The solonoid of this time limit relay is permanently connected across the 550 volt leads, and the control circuit is carried to an interlock, which is in turn opened and closed by the time limit relay plunger. The operation of system is as follows:

The city filter plant operator closes the 11,000 volt circuit breaker and the transformers at the River station receive current and step down to 550 volts. Current is then fed to the selector panel in the pump station, No. 2 switch on the selector panel being left closed, so that current enters the automatic auto starter. The motor does not start at once, however, as the 550 volt control circuit is at this time open owing to the position of the time limit relay, which controls an interlock. However, during this period of time, the time limit relay is being energized simultaneously, and having been previously set for 15 seconds delay, will close at the duration of the 15 seconds, after the city operator has closed the 11,000 volt control circuit breaker. When the control circuit closes, the automatic starter throws the motor on the line from percentage taps and when at proper speed, which is determined by a current limit relay embodied in the starter proper, the motor is cut straight on the line.

To stop the motor the circuit breaker at filter station is opened or if at river, the selector switch which is in control is opened. The automatic motor is protected on the 11,000 volt and also the 550 volt line from single-phase operation by means of two sets of time limit relays in series.

When operating at 11,000 volts with the above equipment, the line losses amount to 1.5% of the total delivered power. The system has been in operation for nine months with from three to five starts per day, and has not failed once during this time. In this connection the writer will also state that the unprotected transformers at the River plant have had several strokes on the line during the past summer, but no trouble whatever has been experienced. The arrangement eliminates the necessity of a man being kept on duty at the river station, and consequently eliminates the cost. The river pumping plant is visited twice during each week for oiling and inspection, and the results from a operating stand-point have been excellent.

The filtration and pumping plants are operated by the Public Works Commission of the City of Rock Hill, S. C., vested with authority to operate the municipal electric light, power and water plants for the city. Dr. J. B. Johnson is chairman, with Mr. F. C. Whitner and Mr. J. W. O'Neil associates.

Some Handy Tools for the Wireman

BY JAMES A. PERRY.

MANUFACTURER'S catalogs contain splendid descriptions of the many standard tools for electrical workers, hence no effort will be made to repeat descriptions of these. It is, however, the intention to discuss a number of devices that have been found useful in practical electrical work, and each can, for the most part, be readily made by the electrician from materials always available. Most of the devices are time and money savers.

First of all, any mechanic should have a convenient serviceable chest in which to store his tools. That shown in Fig. 1 has given excellent service in a number of cases. Its construction is sturdy enough to successfully withstand the hard knocks to which an electrician's chest is subjected. The design shown was, we believe, first introduced by C. C. Payton of the Republic Iron & Steel Company, Sayreton, Ala. The heavy tools are placed in the bottom of the chest while the lighter ones are carried in two trays. One of these trays is attached to the cover of the chest by a series of strap iron links. The arrangement is such that when the cover is open, this tray, *A*, is drawn up with the cover. The other tray, *B*, slides in the usual way on 1-in. x 1-in. guides, while two half-inch strings maintain it in alignment. When the top is open both trays, *A* and *B*, and the tools in the bottom of the chest are at once accessible.

To prevent loss, all tools should be marked with the owner's initials. The marking should be such that it cannot be readily obliterated. A permanent mark can be made on steel tools by the following process with materials that are nearly always at hand. First, the surface of the metal to be marked is covered with a thin coat of paraffin, or drippings from a tallow candle, painted on hot with a brush or rubbed on with the end of a stick. If paraffin or candle is not available, a coating of soap can be substituted. The soap is transferred t othe surface by rubbing the end of a cake against it. With some tool that has a flat point somewhat like a screw-driver, except that it should be only 1/16 in. wide, the owner's initials are engraved through the soap or paraffin, cutting down to the surface of the metal. And the etching solution is next applied with a small stick of wood. The etching solution can be made as follows: One part of table salt (by bulk) mixed with approximately two parts of powdered copper sulphate, or blue vitriol, with the two then dissolved in about ¼ inch of water in the bottom of an ordinary tumbler. After the solution has been applied it will etch the design in the metal to a sufficient depth in a few minutes. The tool can then be washed to remove all traces of the solution, and the paraffin or soap.

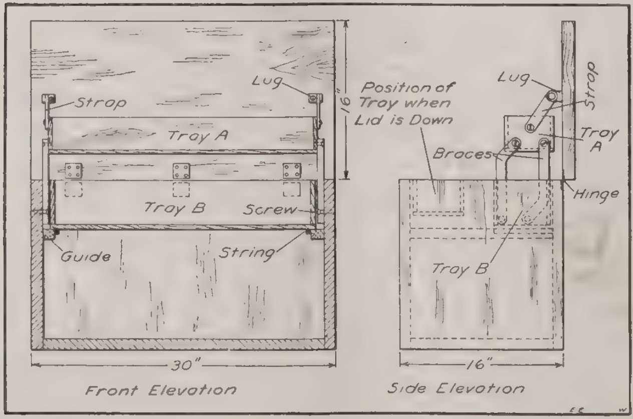


FIG. 1. A CONVENIENT TOOL BOX.

Wiremen should provide themselves with safe ladders. Many designs are in use that afford the safety required. Only a few of these designs which have been given a thorough try-out will be described. The one shown in Fig 2 is particularly useful around shafting, although it is also handy for work in the neighborhood of steel columns, and where the ladder must be leaned against the stiles or rails of a window. As the illustration indicates, the narrow top permits the ladder to be firmly sustained by a shaft hanger, or other similar member upon which it would be difficult to support a ladder of the ordinary type. The lower ends of the two rails of the ladder are shod with strap iron bindings which have pointed ends. This will prevent slipping on wet wood floors.

Where the ladder is to be used on concrete or metal floors, a shoe of one of the types suggested in Fig. 4 should be used. That at Fig. 2 is supported on a pivot, and has a corrugated bottom, hence the shoe always lies normal to the floor. A shoe having pointed spikes extending from its bottom is shown in Fig. 4-*B*. This type is used where the floors are of wood. A shoe with a wood center which will provide considerable friction, and hence tend to prevent slipping even on concrete or iron, is shown at Fig. 4-*C*. Where wood (bass wood is best) does not give sufficient friction, the center member of the shoe shown at *C* can be coated with carborundum or lead, which will greatly increase its adhesiveness. Where lad-

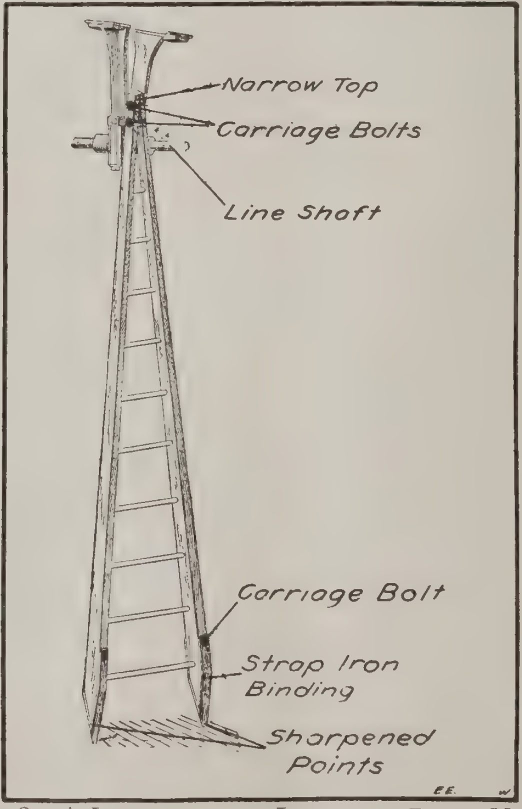
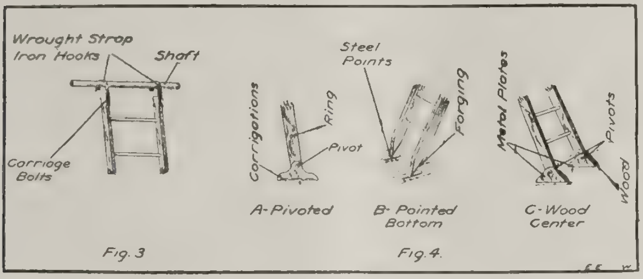


FIG. 2. A LADDER FOR THE INDUSTRIAL PLANT MOTOR TENDER.

ders without narrow tops are in stock and must be used around shafting, strap iron hangers should be bolted to their upper ends as shown in Fig. 3.

A portable bench for the conduit wireman is shown in Fig. 5. This device is particularly useful where the bench has for some reason or other to be dismanteled for transportation. It can readily be knocked down and shipped by rail in a relatively small chest at materially less cost than an un-knocked-down bench can be transported. Benches of essentially this same style have been used by pipe fitters in the Western States where it was necessary to transport the tools on pack animals. To knock down the bench, the unions, of which there are six, are unscrewed. Pipe flanges are mounted at both ends for the supporting of the conduit vises. Boards, if they are available, can be laid across the pipes at the top of the bench. They can also be laid across the bottom pipes to form a shelf. The plates are laid with heavy material of any sort to prevent the bench from rocking while pipe is being threaded. Where boards are placed across the lower pipes the load can be put on these instead of on the plates. It will be noted that every portion of the bench proper is of metal, making it very durable.



Figs. 3 and 4. Hooks and Shoes for Motor Tender and Wiremen's Ladder.

A useful little kit for carrying small tools and fittings such as cleats, bushings, rosettes, locknuts and washers, can be made from a 100 lb. nail keg, as shown in Fig. 6. The keg is sawed in two at the middle, except that one stave in which notches are cut for a handle, is allowed to extend. Some wiremen use a half dozen or so of these carriers on every big job, using each one for some different class of material.

A wireman should never erect wire in an open work installation until all of the kinks or bends have been taken out of it. These bends can, of course, be eliminated if sufficient tension is put on the wire after it is up, but it is much easier and cheaper to straighten the wire before it is placed in the cleats. One good method of straightening wire is shown in Fig. 7. One end of the wire is attached to a nail driven in some stationary substantial object. A knob is run over the wire and then held at an angle and drawn the entire length of the conductor as indicated in the illustration. It is necessary to maintain some tension on the wire while the knob is being drawn along it. This method is best used for No. 14 or No. 12 wires, and may not be successful with larger ones.

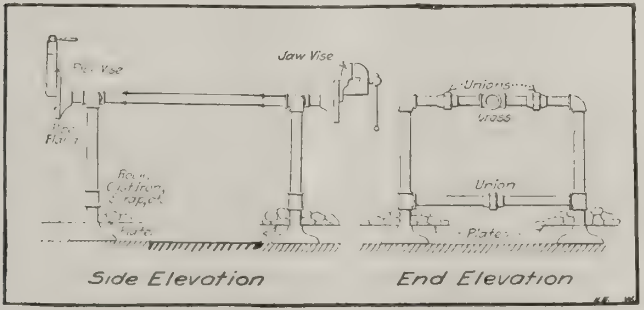


Fig. 5. A Knock-Down Pipe Bench.

There is probably no tool that an electrical worker uses more frequently than he does his pocket knife. If he has its blades ground as show in Fig. 8, a great deal of time and worry will be saved. One of the smaller blades can be ground on an emery wheel as shown in Fig. 8-A. The end being formed to a screw-driver point, of suitable size for socket and rosette work. Near the bolster a notch is cut in the blade. With this notch fixture wire can be "skinned" very rapidly and without breaking it, after the wireman has had a little practice. In use, the end of the wire is placed in the notch and the knife pulled along the wire. The insulation will then soon come off.

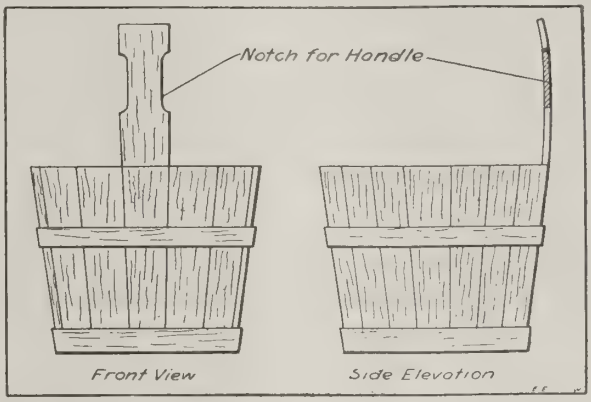


Fig. 6. Carrier for Miscellaneous Supplies.

The large knife-blade, that is used almost exclusively for "skinning" wire can be ground as shown at *B*. As all wiremen know, it is impossible to keep a blade sharp if it is used for scraping insulation, and also for cutting it off. With the grinding suggested, the lower edge can be kept sharp, and used only for cutting the covering while the concave ground, upper surface, which provides two edges, is used for scraping or brightening the wire, after the insulation has been removed. The concave edges are formed by cutting a groove along the top of the blade with an emery wheel. The edge of an electrician's knife will usually

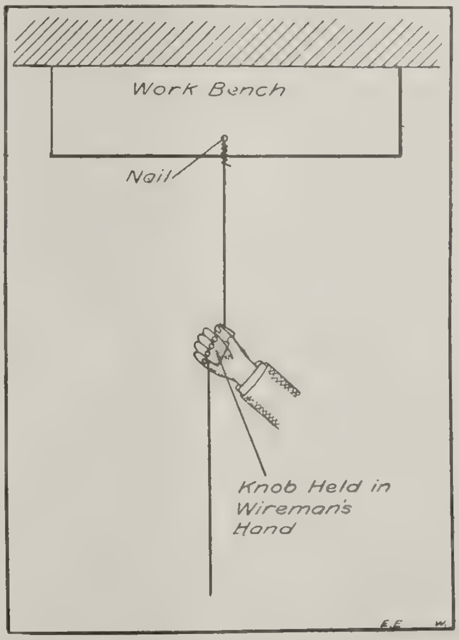


Fig. 7. Straightening Wire With a Knob.

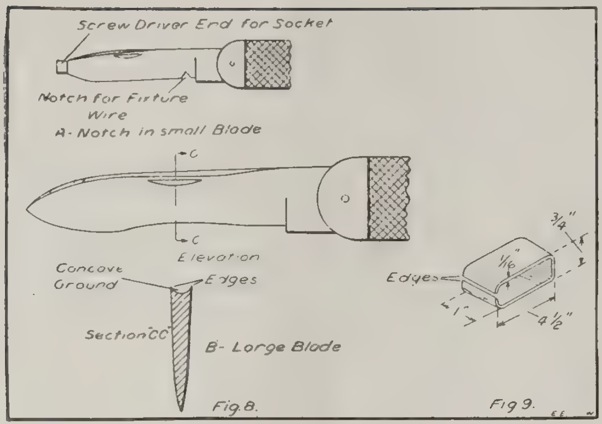


FIG. 8. WAYS OF GRINDING A KNIFE FOR ELECTRICAL WORK. FIG. 9. TOOL FOR SKINNING LAMP CORD.

ultimately assume a curved contour as shown in Fig. 8, *B*, due to constant sharpening. It will be found that if the knife blade used for cutting insulation is ground out rounding, as shown at *B* as soon as the knife is obtained, it will tend to prevent the blade from slipping off the wire.

A little tool, very useful for "skinning" lamp cord, can be made as shown in Fig. 9. In use, the lamp cord is held between the two edges, twisted around therein to cut the insulation around its entire circumference, and then the tool is pulled. The insulation—both the braid and the rubber—will come with it, and the strands will not be broken if the wireman uses just the right amount of pressure on the tool. It can be formed from a strip of steel or iron plate. The edges are made with a file.

In cleat work, Nos. 12 and 14 wire can be tightened very nicely by the device shown in Figs. 10 and 11. A slot, ½ inch deep and ¼ inch wide is cut in the end of the hammer handle, at right angles to the head. The slot being cut, the handle is used as shown in Fig. 10. All wires should be straightened as suggested in a preceding paragraph. After they are partially erected, the sag in them can be pulled out with the hammer handle.

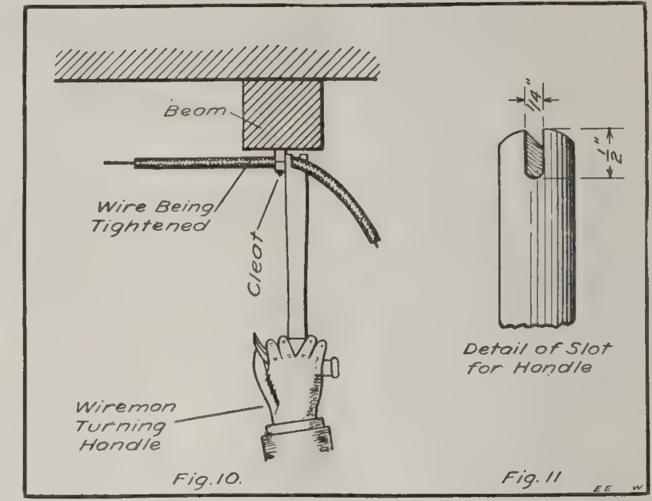


FIG. 10. APPLICATION OF A SLOTTED HAMMER. FIG. 11. SHOWING DIMENSIONS OF SLOT.

The operation of tightening is as follows: The conductor is fastened by clamping in one of the cleats at the far end of the run. Then at the near end of the run a cleat is installed, and the wire placed in it. The screws are set up only far enough so as to bind the wire after it is pulled through and to prevent it from slipping back. Then the end of the wire is inserted in the slot of the handle, and the hammer is turned toward the center of the cleat. The slack being drawn out, the cleat can be fastened with a screwdriver. After the wire has been drawn taut, intermediate cleats can be installed. It will be noted that this procedure eliminates the necessity of lining up the intermediate cleats by measurement.

The next section of this article will take up other useful devices.

Lamps And Lighting Developments in England During 1914

BY R. E. NEALE, B. SC. LONDON, A. C. G. I.

THE outstanding development since the lamp and lighting position in England was last reviewed in these columns, is the introduction of the half watt nitrogen filled tungsten lamp. This lamp was originated at Schenectady, N. Y., and has since been described in *Electrical Engineering*. The writer therefore proposes to outline its general reception, development and prospects in England. The powerful units in which alone the first half watt lamps were available, the large size of the bulbs and the high price of the lamps, limited the sale of the latter when first introduced. Soon, however, relatively low candlepower lamps became available, prices were materially reduced and bulb and neck dimensions reduced. These changes together with the introduction of good fittings for the lamps—demonstration of the fact that two or three times the guaranteed life could frequently be obtained—improved methods of packing and assumption by manufacturers of breakage risks in transit, led to rapid increase in demand and about half a million half watt lamps are believed to be now in use in this country.

Claims and fears were at one time expressed that the new lamp would displace arc lamps. So far as concerns old and inefficient arcs this has been the case with many old arc lamp cases and lanterns now enclosing half watt lamps. The modern flame arc is, however, unassailable and likely to remain so, for even when worked at its melting point, an incandescent tungsten filament could not consume less than 0.3 watt per candle whereas modern flame arcs have about double this efficiency. The cost and trouble of recarboning (often exaggerated) is offset by the cost of renewing half watt lamps. If the price of the latter be halved—as it is quite likely to be in the near future—many arcs, now justifiably kept in service, will be replaced.

During the last twelve months an excellent variety of "half watt" lanterns and glass ware has been placed on the market and in shops, medium sized streets, warehouses and yards are to be seen half watt lamps where previously open or enclosed arcs were employed. Indirect and semi-indirect lighting of interiors has been greatly stimulated by the new lamp, the efficiency of which reduces lighting costs practically to those of good direct lighting using one-watt tungsten lamps. In photographic studios and moving picture projectors, half watt lamps already find considerable use and will doubtless come into yet greater popularity.

The extensive use of such high candle power sources as flame arcs and the larger half watt lamps has directed much attention to high candle power photometry. In the National Physical Laboratory means have been perfected for rotating arc lamps and large tungsten lamps to expedite mean candlepower measurements in all directions and J. F. Forrest has shown that the crater of an arc between pure carbons can be used as a high candlepower standard of light. Since the luminous intensity is of the order of 160 c.p. per sq. mm. of crater, the new standard is very convenient in this connection.

In domestic and small-unit lighting in general, wire drawn tungsten lamps are standard practice. Many carbon lamps are still made for use in basements and warehouses (where strength and low first cost are important considerations) and for Admiralty use. In conversation with persons chiefly responsible for the manufacture of these lamps, the writer learns that the output is likely to be very small in from two to five years time.

Mercury vapor lamps are developing along the lines indicated in previous reviews. Mostly they are used in photographic applications where the high actemic value of their light is valuable; in industrial services and offices where color distortion is immaterial and in advertising and display lighting. The latest form of rhodamine reflector (correcting color by adding red rays) is surprisingly effective and has done much to overcome prejudice against mercury lamps. The Moore lamp is still used only in subways, on stairways and facades and in a few special interiors. Its effect is invariably admired but its relatively low efficiency and the auxiliary apparatus required are against its general adoption. Essentially it is an illuminant for large spaces and in such high efficiency is demanded. The Neon lamp consumes only ½ watt per candle and can be used satisfactorily in more convenient size than the Moore lamp. Like the latter it requires high tension a.c. supply and like the mercury lamp it gives a strongly colored light. On the other hand, it requires no breathing valve and its color—rosy red—is much more pleasant than the green-blue of the mercury arc. In lighting statuary, in gala lighting and in publicity work, Neon lamps have already found useful application. Very striking results are obtained from small neon tubes bent to trace words or ornamental designs. In combination with mercury tubes even more striking effects are produced.

Lighting fittings in this country follow practice in the States. Indirect-lighting fittings are extensively employed in moving picture theatres, libraries and other places of assembly as well as in offices and better class private interiors. Semi-indirect fittings are frequently preferred as being more efficient and giving soft shadows and freedom from the "flat" effect of purely indirect lighting. Half watt lamps are naturally used wherever possible in indirect or semi-indirect lighting schemes. For use in advertising and special interior lighting special marble fittings have been introduced.

Following the example of the American Society of Automobile Engineers, efforts are being made to standardize the shapes and sizes of electric lamps used on motor cars. Electric lighting is standard on the majority of modern British automobiles and during the past season or two many combined electric starters and lighting sets have been placed on the market.

The safe illumination of coal mines is a very important problem in England and many excellent electric lamps are now made for miners' use. These are mostly of the lead accumulator type and given suitable mechanical construction throughout (without which they are not passed for use) the vulnerable component is the battery. Improved methods of charging, testing and record keeping have been devised with the result that the total cost of electric lighting is reduced to 1c per lamp per shift. Nystagmus is appreciably checked where electric lamps are in use. The time is considered ripe for their compulsory adoption.

In the industrial field steady progress is following along the lines indicated in previous reviews. Improved fittings, better arrangement of lamps and the extensive use of half watt tungsten lamps are the outstanding developments. To enter into technical details at the moment would repeat matter, the essentials of which are the same as in American practice. An important report is however soon expected from the Home Office Committee appointed to consider ways and means for industrial lighting.

In the central station field the metal lamp crisis of a few years ago is quite past and the great ultimate increase in lighting demand has come to pass. The introduction of half watt lamps is not likely to cause a recrudescence of the crisis since they are not and are not likely to be, for some time, suitable for general domestic use; further, the relative importance of lighting load has been much diminished during recent years.

Many English central stations have in their districts large numbers of cottage tenants. The supply of such consumers who do or who would use only $5.00 worth or so of current per annum is a difficult problem but once it is solved, there are so many such customers, that the aggregate profit immensely strengthens the position of the station. Cheap surface wiring systems and the use of contract tariffs (to eliminate the cost of meters and bills) are among the first means to be adopted in securing such loads. In Wednesbury very satisfactory results have been obtained by a "pay-in-advance-weekly" system incorporating free wiring, lamps and repairs and returning $45 per annum for the first three years and thereafter $90 per annum net profit per one kilowatt of maximum demand; keeping the latter low is a more important consideration than eradicating every slight wastage caused by needless burning of lamps. This is far better remuneration than obtainable from any other class of consumer and the extension of cottage lighting in this country is undoubtedly going to be most important to supply authorities as well as beneficial to the public.

The unexpected outbreak of the war in Europe found British electrical manufacturers well able to weather the crisis. With the exception of firms factoring German and Austrian houses, electrical business is good—in some cases exceptionally so—and in future, it is going to be yet better.

Convention of American Electric Railway Association at Atlantic City.

The annual convention of the American Electric Railway Association and its affiliated associations was held at Atlantic City during the week of October 12 to 16. This meeting of electric railway men is now looked forward to as the important event of the year and one in which decided interest is shown by officials, operating men and manufacturing companies who solicit business from electric railway companies. The exhibits by manufacturers are always an important and interesting feature of this convention and this year there was no evidence of any material curtailing either in the nature or extent of exhibits and no sign shown of a hampering due to financial and war conditions.

The keynote to the present situation in the field was struck by President Chas. N. Black of the American Electric Railway Association in his address. He said:

"Since 1910 there has been a marked falling off in new construction and a reluctance on the part of investors generally to place their money in electric railway securities. In a large measure this has been brought about, no doubt, through governmental regulation. Capital is inherently shy, and always ceases to flow readily when any radical changes occur. In other industries, such as banking, manufacturing, mining, etc., a rate of return ranging from 10 per cent to 20 per cent, or even more, is not considered either remarkable or unreasonable, while in the case of public utilities the state commissions generally have limited the rate of return to a maximum of 8 per cent, and this oftentimes on a depreciated valuation. The reasons given for this comparatively small allowance are based upon the assumption that the business of a public utility is more stable and less subject to competition than other industries.

"While it is true that under the laws in many states at the present time, public utilities are not as subject to competition as other industries, they are not entirely free from it, and it is not true that they are not fully as subject to many other contingencies which may radically affect their income. A striking example is found in the inauguration of motor-bus service in a number of cities and, whether or not these prove successful in the long run, they certainly for the time being materially affect the income of the street railways. Furthermore, all our public utilities, with possibly the exception of water supply, are subject to radical changes in the art, making it necessary oftentimes to discard or scrap large parts of the investment long before it is worn out. Provision for this obsolescence cannot possibly be made without setting up reserves far in excess of what would be permitted by any of the commissions.

Capital will naturally seek those investments in which the rate of return is the highest, due sonsideration being given to the security of the investment. Unless this fact is recognized by the state commissions and a rate of return allowed commensurate with the risks involved and with the returns which can reasonably be expected from other lines of industry, it will be absolutely impossible to secure fresh capital either for extending present plants or for exploiting new ones."

REFORT OF ENGINEERING ASSOCIATION.

The first session of the Engineering Association was opened by President J. H. Hanna, of the Capital Traction Company, Washington, D. C., Monday afternoon at 2 o'clock. At this time the address by the president of the engineering division was delivered. The work of the various committees of the association were referred to and a plan mentioned to reduce the number of subjects assigned to each committee during the coming year on account of limited time in which to consider the reports at the annual convention. The compilation of the engineering manual, as a result of the work of the standards committee was especially complimented. Something over 1,000 copies of this manual have already been distributed and President Hanna urged members to assist in the distribution and the sale of it not only on account of the financial help it would be to the association but so that the work of the association in establishing standards would be utilized and appreciated to its fullest extent. The cooperative work of the association with other associations was taken up, particularly the arrangement with the Central Electric Railway Association providing for a prompt reference to the standard committee of any standards adopted by that association.

The report of the committee on power distribution presented at this session contained recommendations that specifications for rubber insulated wire and cable for power distribution be adopted as standard; that a new set of specifications for round and grooved trolley wires as submitted be substituted for the present standard specifications for No. 00 hard drawn copper trolley wire; that a revision of specifications for galvanizing on iron and steel as submitted be adopted; that certain specified changes be made in the recommended specifications for 600 volts direct current over head trolley construction and that certain minor changes be made in cables, etc., in the engineering manual. The committee also recommended that further investigation be given to the subject of concrete poles and a further investigation be given preliminary to the preparation of specifications for sundry line materials.

In the report of the committee on electrolysis presented at this time, the following work was outlined as the result of activity during the past year: 1. A simple presentation of Kelvin's law in easily workable form for the determination of the economic voltage drop in direct current feeders. 2. The development of a formula and graphic chart showing the economic replacement resistance of rail bonds. 3. A consideration of a proper value to be used in discussing the energy saving to be effected by the addition of feeders. 4. A discussion of the limitations of potential and return circuit. 5. A bibliography on the subject of electrolysis. The committee will continue making a study of electrolysis.

The session on Tuesday morning was held jointly with the Claim, Transportation and Traffic Associations. The first subject presented was the report of the board of accident prevention. In taking up this subject, the statement was made that a casual examination of the subject of accidents in the industry indicates that conditions are indeed serious. According to records by the New York Edison Company 85 per cent of accidents are due to employees carelessness or negligence, 6 per cent due to carelessness of fellow servants, 2 per cent due to outside contractors and 7 per cent chargable to the company. The Ausable Electric Company of Michigan in a recent report states that 75 per cent of their accidents are due to carelessness. The committee stated that a campaign designed to prevent accidents must be based upon the natural tendency of human beings to be careless and to be effective the work must be carried on with enthusiasm. Once instituted the safety department of a corporation should be considered a permament feature and the effort should not be allowed to lag.

A report of the committe on block signals stated that a sub-committee was at work with the committee from the Railway Signal Association and during the next year would select from among the standard designs of Railway Signal Associations such ideas as could properly be adopted as standard for the American Electrical Railway Association. Certain suggested rules for signals were presented and approved.

The report of the committe on Transmission Engineering reported on train operation in passenger service, train operation in freight and express service, and effect of car and equipment design on the duration of stops. Data was presented to show that on a 6600 volt single phase line in the middle west, single trains on a holiday permitted an increase of 158 per cent in seating capacity and 122 per cent in ton miles at an increase of only 76 per cent in energy consumption. In regard to freight and express service the committee found that with increasing length of trains and runs for the permissable schedule speeds, the tendency being to use a single motor car or electric locomotive with trailers instead of multiple-unit equipment. For interurban work the committee found that the double-end two or three compartment car was generally conceded to be the most flexible design and it believed that end doors should be incorporated in all cars to meet possible train operation.

At the session held Wednesday morning reports of committees on equipment, standards, buildings and structures were presented. As regards equipment, the revision of specifications for heat-treated carbon steel, axles, shafts, etc., was approved. The recommendation of the committee that it be instructed to prepare specifications for gears and pinions was also approved. It was further approved that the standards committee on equipment take up the general subject of car wiring with special reference to fire protection. The lighting of electric cars taken up in a paper by L. M. Clark was found in the report as an appendix.

During a discussion on lightning protection it was recommended that the committees on equipment, power, generation, distribution, and block signals be instructed to continue the subject of lightning protection in its relation to car and line equipment. The report of the committee on buildings and structures showed that the following subjects were under consideration: "Fire Protection Rules;" "General Specifications and Form of Contract" and "Power House Construction."

On Thursday the reports of committees on life of railway physical property, engineering and accounting and reports of committees on power generation and standards were presented. The first named reports were delivered at a joint session with the Accountants Association. The report on engineering accounting covered the subjects of overhead charges, interdepartmental charges and cost accounting.

The chairman of the committee Life and Railway Physical Property reported that considerable work had been done along the lines outlined in 1912-1913 but that the committee was not ready to submit a report. The committee was continued.

A report of the committee on power generation took up the status of automatic stokers, control and safety devices for power stations and feeder circuits with special reference to reactance and advantages and disadvantages of 60 cycle apparatus with special reference to rotary converters for railway service. In referring to stokers costs, it was stated that comparative prices of the various stokers per rated horsepower of boiler are of little value unless the forcing caacity maintenance and labor attendance are taken into account. It was further stated that the field narrows down to chain grates for a high voltage high ash-coal and gravity underfeed for practically all other classes. It was further stated that the underfeed may eventually take the whole field. The section of the report on control and safety devices took up principles of operation and part played by natural and artificial reactance in power plant and transmission lines, particularly as affecting short circuit currents, load distribution and synchronizing power of synchronous apparatus. The discussion on 60 cycle apparatus was practically a review of features of 60 cycle apparatus as compared with 25 cycle apparatus. It was stated that there is little choice between the two frequencies as far as turbo-generators are concerned except that with high speed generators the regulation may not be quite as reliable in 60 cycle machines when the load is variable. The damage from short circuit current also may be intensified. These machines are slightly more efficient and they are cheaper as are also synchronous motors for the higher efficiency.

Under abnormal supply conditions, it would seem that the 60 cycle rotary is more sensitive to flashing than the 25 cycle one. From the standpoint of efficiency the 25 cycle rotary converter is slightly better but the advantage is neutralized or even reversed when transformer efficiency is included.

The session on Friday took up way matters and covered proper foundations for tracks in paved streets, use of T-rails in paved streets, pavements for use in connection with girder and high T-rails and alloy steel rails. The report of the committee on heavy electric traction included a revision of recommended designs covering clearances of overhead conductors, the revision consisting in a diagram giving a 15 foot, 3 inch clearing for overhead direct current conductors. It was recommended to continue the study of clearance lines for third rails and the study of modern electric locomotives.

At the session on Friday Mr. L. P. Crecelius was elected president of the engineering association for the coming year. Mr. Crecelius is the superintendent of motive power and electrical engineer of the Cleveland Railway and has held responsible positions with several large systems during the past 15 years. He has been active in association work in connection with the American Electric Railway Association and with the American Institute of Electrical Engineers. He has advanced to his present office from vice-president of the association and has had the opportunity to become familiar with administration problems which places him in a position to render the association valuable aid during the coming year.

Mr. C. Loomis Allen, the first president of the American Electric Railway Transportation and Traffic association and now of the firm of Allen and Peck, Inc., managers of public utility properties, was elected president of the American Electric Railway Association, the parent organization.

New Business Methods and Results

Representing Interests of Central Stations, Electrical Jobbers, Dealers and Contractors.

Robert Montgomery, Manager Commercial Department Louisville (Ky.) Gas & Electric Company Secures 1,776 House Wiring Contracts in Eight Months.

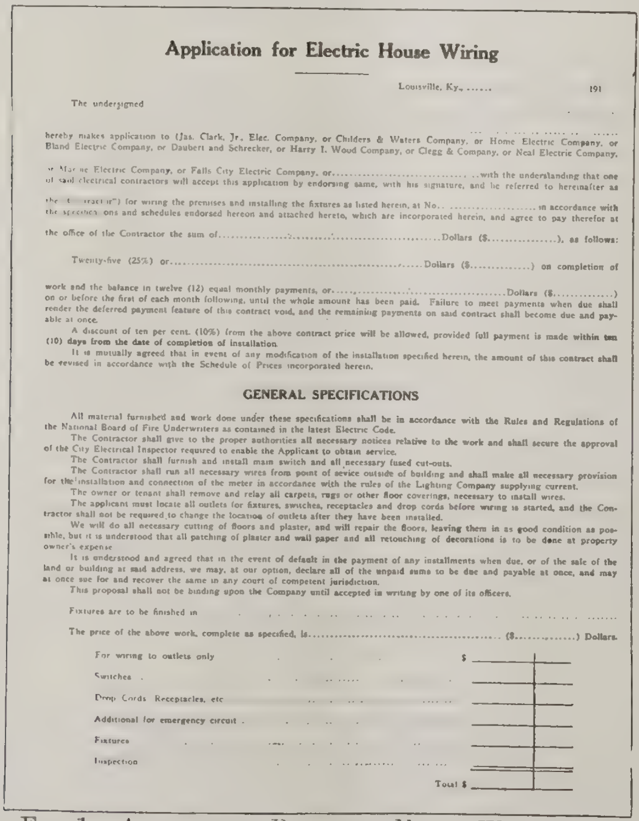
In the April issue of ELECTRICAL ENGINEERING, the details of a house wiring campaign were presented as worked out and launched about the first of February of this year by the Louisville Gas & Electric Company. The campaign has been a success from the very start as evidenced by the fact that up to this writing (Oct. 17) 1776 contracts covering wiring and fixtures have been secured representing a value of $75,469.19.

This campaign was outlined by Mr. E. L. Callahan, manager of New Business Department of H. M. Byllesby and Co., of Chicago, and has been conducted under the direct supervision of Robert Montgomery, manager of the commercial department of the Louisville company, whose experience in the Byllesby organization has enables him to work out and refine the general scheme and profit by others that have already proven a success elsewhere. As might be expected several changes have been found advisable in conducting the campaign, however, in the main the original details, such as form of application for wiring, general specifications and schedule of prices remain the same as reported in the issue above mentioned. The present form of application has, however, been condensed and arranged in a more convenient manner, the illustrations in Figs. 1 and 2 showing the front and back of the contract now in use.

As the campaign has progressed, it has seemed advisable to apportion the work among all the contractors in good standing in Louisville and the names of such are incorporated in the contract as shown.

In commenting upon the campaign and the method of conducting it, Mr. Montgomery says: "The contracts are secured by our solicitors and brought into our office and divided among the ten contractors who cooperate with us in the campaign. Until about three weeks ago, five house wiring salesmen were mployed. The city was divided into five districts and one man placed in charge of each district. During the past three weeks, however, two of these men have been transferred to the gas department to assist in a gas heating campaign now being carried on, leaving three men in charge of the house wiring proposition. The two men taken off the house wiring campaign will be again detailed to the work within the next thirty days.

"It will be understood from an inspection of the contract that our company is not a party thereto but simply acts as an agent in closing the contracts for the contractors. Our company of course does all the newspaper advertising at its own expense. The contractors do the work on the time payment plan allowing the customer to pay 25 per cent of the amount upon completion of the work and the balance in six monthly payments. In the event the whole amount is paid in cash, a discount of 10 per cent is allowed. The solicitation of this business is confined entirely to old residences which are located upon our present lines. No business houses are wired on these terms.



Application for Electric House Wiring

Louisville, Ky., ... 191

The undersigned

hereby makes application to (Jas. Clark, Jr., Elec. Company, or Childers & Waters Company, or Home Electric Company, or Bland Electric Company, or Daubert and Schrecker, or Harry I. Wood Company, or Clegg & Company, or Neal Electric Company, or Marine Electric Company, or Falls City Electric Company, or..............................with the understanding that one of said electrical contractors will accept this application by endorsing same, with his signature, and be referred to hereinafter as the "Contractor") for wiring the premises and installing the fixtures as listed herein, at No.. .... in accordance with the specifications and schedules endorsed hereon and attached hereto, which are incorporated herein, and agree to pay therefor at the office of the Contractor the sum of..Dollars ($................), as follows:

Twenty-five (25%) or..Dollars ($..............) on completion of work and the balance in twelve (12) equal monthly payments, or...Dollars ($.............) on or before the first of each month following, until the whole amount has been paid. Failure to meet payments when due shall render the deferred payment feature of this contract void, and the remaining payments on said contract shall become due and payable at once.

A discount of ten per cent. (10%) from the above contract price will be allowed, provided full payment is made within ten (10) days from the date of completion of installation.

It is mutually agreed that in event of any modification of the installation specified herein, the amount of this contract shall be revised in accordance with the Schedule of Prices incorporated herein.

GENERAL SPECIFICATIONS

All material furnished and work done under these specifications shall be in accordance with the Rules and Regulations of the National Board of Fire Underwriters as contained in the latest Electric Code.

The Contractor shall give to the proper authorities all necessary notices relative to the work and shall secure the approval of the City Electrical Inspector required to enable the Applicant to obtain service.

The Contractor shall furnish and install main switch and all necessary fused cut-outs.

The Contractor shall run all necessary wires from point of sevice outside of building and shall make all necessary provision for the installation and connection of the meter in accordance with the rules of the Lighting Company supplying current.

The owner or tenant shall remove and relay all carpets, rugs or other floor coverings, necessary to install wires.

The applicant must locate all outlets for fixtures, switches, receptacles and drop cords before wiring is started, and the Contractor shall not be required to change the location of outlets after they have been installed.

We will do all necessary cutting of floors and plaster, and will repair the floors, leaving them in as good condition as possible, but it is understood that all patching of plaster and wall paper and all retouching of decorations is to be done at property owner's expense

It is understood and agreed that in the event of default in the payment of any installments when due, or of the sale of the land or building at said address, we may, at our option, declare all of the unpaid sums to be due and payable at once, and may at once sue for and recover the same in any court of competent jurisdiction.

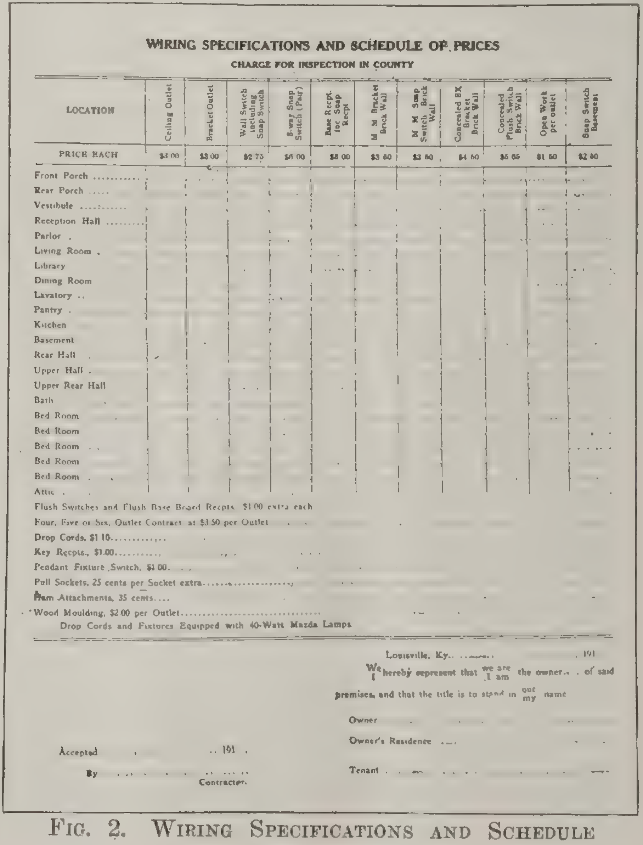
This proposal shall not be binding upon the Company until accepted in writing by one of its officers.

Fixtures are to be finished in ....

The price of the above work, complete as specified, is...($..............) Dollars.

For wiring to outlets only	$
Switches	
Drop Cords Receptacles, etc	
Additional for emergency circuit	
Fixtures	
Inspection	
Total $	

FIG. 1. APPLICATION FORM FOR HOUSE WIRING AND GENERAL SPECIFICATIONS.



WIRING SPECIFICATIONS AND SCHEDULE OF PRICES

CHARGE FOR INSPECTION IN COUNTY

LOCATION	Ceiling Outlet	Bracket Outlet	Wall Switch including Snap Switch	3-way Snap Switch (Pair)	Base Recpt. inc Snap Recpt	M M Bracket Brick Wall	M M Snap Switch Brick Wall	Concealed BX Bracket Brick Wall	Concealed Flush Switch Brick Wall	Open Work per outlet	Snap Switch Basement
PRICE EACH	$3 00	$3.00	$2 75	$6 00	$8 00	$3 60	$3 60	$4 60	$5 65	$1 60	$2 60
Front Porch											
Rear Porch											
Vestibule											
Reception Hall											
Parlor											
Living Room											
Library											
Dining Room											
Lavatory											
Pantry											
Kitchen											
Basement											
Rear Hall											
Upper Hall											
Upper Rear Hall											
Bath											
Bed Room											
Bed Room											
Bed Room											
Bed Room											
Bed Room											
Attic											

Flush Switches and Flush Base Board Recpts. $1.00 extra each

Four, Five or Six, Outlet Contract at $3.50 per Outlet

Drop Cords, $1.10..............

Key Recpts., $1.00............

Pendant Fixture Switch, $1.00.

Pull Sockets, 25 cents per Socket extra........................

Fan Attachments, 35 cents....

Wood Moulding, $2.00 per Outlet..................................

Drop Cords and Fixtures Equipped with 40-Watt Mazda Lamps

Louisville, Ky.. 191

We I hereby represent that we are I am the owner.. of said premises, and that the title is to stand in our my name

Owner

Owner's Residence

Tenant

Accepted .. 191

By .... Contractor.

FIG. 2. WIRING SPECIFICATIONS AND SCHEDULE OF PRICES.

"The solicitors carry a fixture catalog illustrating the line of fixtures furnished at campaign prices and care is exercised in selecting a standard line which can be furnished by all of the dealers. No commissions are paid the contractors by the company for doing the work as has been done in some cities. The only expense incurred by the company is the cost of advertising and solicitation. We believe that we have only fairly started in this campaign and intend to carry it on for at least two more years."

Experiments at Seattle, Washington, With Electric House Heating.

In the last report compiled by Mr. J. D. Ross, an electrical engineer in charge of the municipal lighting department of the City of Seattle, Wash., considerable interesting data on experiments to determine the practicability of using electricity for heating houses was given. During the past two years several houses have been fitted up by their owners with electric heaters, both of the direct radiation type and the type used in connection with hot water radiators. The lighting department connected these houses to its mains, made a special rate for current and kept complete records of the temperatures maintained in the house and the amount of current used.

The first house equipped was of concrete construction with solid 8½ inch walls, and contained five rooms, having a total floor area of 418 square feet, a cubic capacity of 3252 cubic feet, an outside wall area of 491 square feet, and a window area of 127 square feet. In this house were installed five electric heaters of the direct radiation type, of which three were 2 kw. and the other two had a capacity of 1½ and 0.6 kw. respectively. Recording meters were placed in the service to measure the current; and the daily maximum, average and minimum temperatures, both outside and inside the house, were observed and recorded. The total consumption for the year amounted to 10,250 kw. hours, running from 2430 kw. hours in December to 20 kw. hours in July. An average temperature of 70 degrees was maintained inside the house, and the minimum at night was kept above 58 degrees. The mean outside temperature was 51 degrees and the minimum, 26 degrees.

In this house no discrimination was made with regard to the time of day when the current was used. Another method of using electric heat was to install an electric hot water heater to replace, or to be used in conjunction with, the regulation boiler on a hot water heating system. In theory this method is less efficient than when direct radiating heaters are used, on account of a slight loss in the piping of the hot water system. An advantage which more than offsets this slight loss is that a hot water storage tank may be installed which will supply heat to the house for several hours after the current is turned off, and in this way the supply of current may be cut off during the hours of maximum demand on the lighting plant for current for lighting purposes. With this scheme of electric heating, enough customers can be supplied with current for heating purposes to exhaust the full capacity of the present distribution system without any further installation whatever except for the mere service wires from the pole to the house, since the heaters will be cut off during the hours when light is used. There are now four houses equipped with the hot water system of electric heating on the city's lines. Experience shows that 1 kw. of heater capacity will supply 20 square feet of radiation and will require 20 gallons of storage tank capacity to supply heat during the lighting peak in winter. The cost of making the installation, which is borne by the customer, will run from $10 to $25 per kilowatt capacity of the heater, depending on the size and layout of the house. This expense includes merely the wiring and installation of the electric heater and the cost of the heater itself. The records show that in one house of frame construction having 200 feet of radiation supplying four rooms with outside wall area of 846 square feet and window area of 201 square feet and cubic contents of 7,290 cubic feet, the monthly consumption of current during the winter months averages 3,000 kw. hours, with a temperature maintained in the house at 68 to 70 degrees, and the average monthly consumption for the entire year will amount to about 13,000 hours.

To sum up, the results of all the heating experiments to date are: Electrical heating for homes is perfectly feasible and is the most convenient and cleanest method. Despite the fact that heaters of 100 per cent efficiency are used, the amount of current needed makes the expense at present rates several times that for heating with coal. One pound of coal contains as much heat as three kw. hours in electricity, and with coal at $6 per ton and current at 2 cents per kw. hour, the coal costs 0.3 cents as against 6 cents for the current, a ratio of 20 to 1 in favor of the coal. This is partially offset by the fact that all of the heat of the current is utilized, while from 30 to 80 per cent of the heat of the coal is wasted. Compared on a basis of cost, electricity at one-half cent per kw. hour is from 25 per cent to 40 per cent higher than coal at $6 per ton

While electric heating must be regarded as a luxury at the present rates, this is not true of electric cooking. Scores of people in Seattle depend upon electricity altogether for cooking and uniformly agree that it is the most convenient, safest and cleanest method and no more expensive than any other method. The lighting department is encouraging the use of electric current for cooking and has made a rate of 3 cents per kw. hour for this class of service. The engineering staff of the department has collected data on electric cooking and heating and is ready to assist customers who wish to use current for this purpose. An average of all the bills rendered during the past two years shows that the average monthly bill for current for electric cooking is $3.03.

Safety First Device Used by Louisville (Ky.) Garage.

A "Safety First" scheme of decided merit has been installed by the Southern Motors Company of Louisville, Ky., designed to prevent collisions with pedestrians when vehicles leave the garage. On leaving this garage motor vehicles are obliged to cross the sidewalk of a busy street along which pedestrians are passing all hours of the day and night, and as a warning a red lamp has been installed in front of the exit in a large globe, on each side of which the word "danger" is painted in large letters. This lamp is lighted from sunset to sunrise and in itself forms an effective cautionary signal. It is, however, supplemented by a loud-ringing gong, which is automatically operated whenever a vehicle approaches the exit door, a steel plate being so placed that it automatically closes the contact with a copper spring and rings the bell whenever the wheels pass over it.

Local authorities would do well to enforce the installation of such a device at the entrance to every garage located on busy thoroughfares.

Concerning the Electrical Trade

News of Activity by Manufacturers, Jobbers, Dealers, Contractors and Engineers.

James L. Kirkland, Southern Representative of Economy Fuse and Mfg. Company, a Pioneer in Electrical Work.

There is no one thing that calls attention to the fact that the electrical industry is still young, as the reminiscences of some one of the few men who were connected with the first electrical construction work, a time when electrical machines were rated in number of lights and kilowatt capacity a thing yet to be learned. Such a pioneer is Mr. James L. Kirkland and many are the interesting experiences he relates with such men as Thomas A. Edison, Edward H. Johnson, Edison's superintendent, E. T. Greenfield, his wiring foreman, W. S. Andrews, now with General Electric Company, A. N. Vail of the original Edison Electric Illuminating Company of Boston. He was also intimately acquainted with the late Luther B. Sterringer well known as the inventor of the first commercial combination electric fixtures and largely responsible for the illumination and displays at the Cotton States Exposition in Atlanta in 1895, the World's Fair at Chicago and the Pan American Exposition at Buffalo.

Mr. James L. Kirkland was born in Philadelphia, Pa., February 26, 1869, and began in electrical work with the Marine and Inland Telegraph Company, working on the construction of the first telegraph line from Philadelphia to Pittsburgh. This company was organized by his grandfather, the Hon. James L. Shaw, who was its president until it became a part of the Western Union Telegraph Company in the early eighties. Mr. Kirkland left the telegraph field to go with the Edison Electric Company, working under Mr. E. H. Johnson, then general superintendent of construction. His first work with the Edison Company was in connection with the completion and starting of the generating station at Sunburry, Pa., the first three-wire central station to be built by the Edison Company outside of New York City. Later he worked on the first lighting plant of the Commonwealth Edison Company of Chicago, at Adams Street and under the late Charles Holmes.

Mr. James L. Kirkland, a Pioneer in Electrical Construction.

After some eight years with the Edison Company, Mr. Kirkland went with the Westinghouse Electric Company working under G. O. Fairbanks in the erecting department. At this time he was detailed to the operation of station equipment just before being turned over to local managements, being known as a "30-day man," a term created by reason of the fact that 30 days of successful operation was then considered sufficient demonstration of a successful installation and proof of readiness for acceptance. In 1892 Mr. Kirkland left the Westinghouse Electric Company to become superintendent of construction for the W. S. Reed and Company of Chicago, spending the first year in wiring different buildings at the World's Fair and later other buildings in Chicago. In 1896 he resigned this position to go into sales work for the American Circular Loom Company, covering the eastern territory for some six years, leaving in 1902 to go with the Electric Supply Company of Memphis, Tenn.

An illness in 1908 forced Mr. Kirkland to give up active work and during 1909 and 1910 he devoted part of his time as manufacturers agent with headquarters at Memphis representing Machen and Mayer Electric and Mfg. Company and Philadelphia Electric and Mfg. Company, and during 1911 traveled in the South for the Central Electric Company. In 1912 and 1913 he was again located in Memphis as contract agent for the Wagner Electric Company, a local dealer in electrical supplies and fixtures. While in this position he was interested in a proposition made by the Economy Fuse and Manufacturing Company of Chicago, and accepted the position of sales representative for the Southern states with headquarters in Memphis, which position he now holds.

Mr. Kirkland is a brother of Mr. Harry B. Kirkland, vice-president and sales manager of the American Conduit Mfg. Company of Pittsburgh, both being as widely and as well known as any two brothers connected with the electrical supply and jobbing business today. Both have a characteristic genial nature and personality that once known will never be forgotten. Mr. James L. Kirkland in 1892, married Miss Elizabeth Dunn of Rock Island, Ill.

Installation, Operation and Maintenance

This section is devoted to practical suggestions, experience and data, and is open to all readers who have something to say on every day work and trouble in the plant or sub-station, on the line, in the factory, mill or elsewhere.

Losses in the Distribution of Electricity.

That a considerable loss takes place in the distribution of electricity between the central-station switchboard and the lamps in the customer's building, is generally understood. However, the extent of these losses and their apportionment among the components of the distribution system is not appreciated by the average person. In what follows the writer gives some data compiled from careful estimates, relating to the losses in a 2400-volt, two-phase distribution plant in a middle west city of 7,000 inhabitants. It is believed that the data secured in connection with this installation are fairly typical of those relating to average plants in towns of from 5,000 to 15,000 inhabitants where 2400-volt alternating-current distribution systems are in operation.

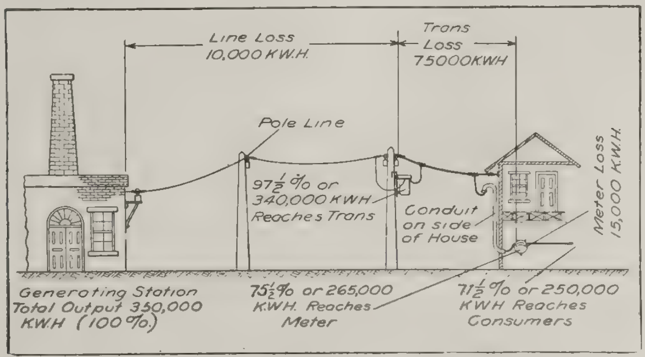


FIG. 1. DIAGRAM SHOWING WHERE LOSSES TAKE PLACE IN DISTRIBUTION SYSTEM.

During the year 1913, 250,000 kw-hrs. were delivered to the customers of this central-station, this value being obtained by adding together the meter ratings of all the customers. During the same period there were delivered to the switchboard in the central-station 350,000 kw-hrs. Obviously the loss in the distribution plant was 100,000 kw-hrs. during this year. By careful calculations, it was ascertained that the annual line loss was about 10,000 kw-hrs and that the annual transformer loss was 75,000 kw-hrs and the meter loss was 15,000 kw-hrs. It is evident, then, that the total distribution loss was equivalent to 40 per cent of the energy delivered. These values together with others are given in Table 1 and Fig. 1 shows where the losses take place. A study of Fig. 1 will emphasize the importance of installing transformers having as high efficiencies as possible, inasmuch as the transformer loss was, in the case studied, the greatest of any of the losses in the system. The meter loss was greater by 5,000 kw-hrs. than the line loss. A study of this condition will probably upset the usually accepted idea that the loss in the line between the central-station and the transformers is the largest one in the distribution plant.

TABLE 1. LOSSES IN THE DISTRIBUTION OF ELECTRICITY.

Item	Annual Kilowatt Hours	In per cent of Elec. Gen.	In per cent of Elec. Deliv.
Line loss	10,000	2.9	4.0
Transformer loss	75,000	21.3	30.0
Meter loss	15,000	4.3	6.0
Total distribution loss	100,000	28.5	40.0
Generated by station	350,000	100.0	140.0
Delivered to consumer	250,000	71.5	100.0

Geo. Gilman.

What Should Lowest Value of Insulation of Power Lines Be?

Much has been written about economy and efficiency in the boiler and engine room. Experiments galore have been made to determine the cheapest and best illumination; good money has been spent for the construction of pole lines with the latest and best of insulators, etc., but how much time is being spent to keep up the efficiency of insulation? Some one has said that all high voltage wires should be used bare for the reason that the insulation on the outside deteriorates making such worse than none especially in wet weather. Yet how about the insulation of other apparatus? Transformers may develop winding trouble that if corrected in time might save money, prevent a fire, or even loss of life.

You may say, "What is all this about?" The answer is, "An insulation test!" The writer believes that during dry weather or say two days after a rain, and never less than once a month, some or all apparatus circuits should be tested, for it is certain that if faults show up during dry weather, they may be expected to be greater during wet weather. It must be remembered that there is hardly such a thing as perfect insulation on outside circuits where a pole line is involved but such can be approached.

Let us strike a basis for insulation calculations and then "shoot trouble." Since power and lighting lines range in voltage from 220 A. C. up and as 500 volts D. C. is common, we will consider this latter voltage the testing emf. We will also assume that the average city circuit is about 5 miles long for easy calculation. The insulation test will now be taken up. The connections for this test are shown in Figs. 1 and 2. While the 500 volt generator shown grounded in Fig. 1, the details of Fig. 2 show the arrangement.

Suppose the test shows a deflection of 5 volts on the voltmeter, and the resistance of the voltmeter is about 50,000 ohms, then R the insulation resistance can be found from the following formula:

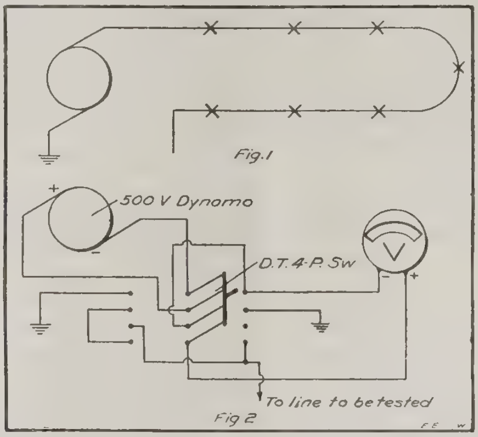
$$R = [(E - E') \div E'] \times W$$

R per mile = R $\times$ Number of miles of circuit. Also in this formula, E is the testing voltage; E′ the voltmeter deflection with the circuit open; W the resistance of the voltmeter; R the insulation resistance corresponding to voltmeter reading and M the insulation per mile. In the above example we have, a 5 mile circuit showing 5 volts deflection and a testing voltage of 500 volts D. C. Then, R is as follows:

$R = [(500 - 5) \div 5] \times 50{,}000 = 495{,}000$ ohms.

$M = 495{,}000 \times 5 = 2{,}475{,}000$ ohms, or 2.46 megohms.

The question now comes up, shall we consider 2.5 megohms per mile good insulation for a lighting and power circuit, when telephone and telegraph companies secure 100 megohms per mile and even better? This is a subject for discussion and the writer puts the question, "What should the minimum insulation be for a power line?"



FIGS. 1 AND 2. DIAGRAM OF CONNECTIONS FOR INSULATION TEST.

For testing purposes, a board could be fitted up near the main switchboard and data secured for determination of the minimum insulation. In this way plant operators would be able to locate little things before they become great. If anyone has tried out a scheme of this kind, "What are your views?" or better "What are your results?"

J. B. Dillon.

How to Select a Boiler Feed Pump.

The selection of a boiler feed pump in both small and large plants does not get the attention that it should. About all the attention that is given, is to make sure that the machine is sufficiently large so that the speed will not be too rapid, and that the water end will be of a certain type. This is all right so far as it goes, but the most vital point is not touched upon at all.

For plants of small size the piston type pump is usually selected for this class of pump is easily taken care of in most instances. The main trouble with it, is the fact that when it leaks around the water piston there is no way of detecting this trouble, whereas in the outside plunger type of pump, any leakage around the plungers is on the outside, and readily detected. For a plant of 300 to 400 horsepower and over the writer believes that the outside packed plunger type of the center packed pattern should be used. This type of pump is made in the center packed, and end packed, the latter being a little easier to get at for packing but takes up much more room.

The purpose of this article is not to discuss the different types of pumps so much, but the proper size pump for a given service, and to show how a selection should be made in order that the steam economy may be the best. We all know that the ordinary steam driven duplex or simplex pump is the most extravagant type of machinery that one can select, and for this reason we should make the selection the best that is possible, so that steam may be saved as much as possible.

In what follows we will also show how the "slip" in a pump will seriously effect the amount of steam that the pump will use in doing a certain amount of work. What is meant by pump slippage is that the valves, both suction and discharge, will allow the water to work back after it has been pumped up. This item is very serious and many pumps in every day service have as much as 50 to 60 per cent slippage, which means that such a machine is using just twice as much steam as it should to do its work.

In order to make the points mentioned plain, we will assume a plant of 500 horsepower and select a pump for same, showing also how much steam this pump will use with different values for "slippage."

The pump will have to handle $500 \times 30 = 15{,}000$ pounds of water per hour or $15{,}000 \times .002 = 30$ gallons per minute. In most cases the pump will have to handle hot water (there being an open heater in service) and under these conditions the pump should be large so that the speed will be slow in order that the pump may not pull to high a vacuum on the suction and cause the water to be flashed into steam and make the pump race as it were.

At 15 feet per minute, we find that a pump with a 5 inch diameter water cylinder would be right. From standard pump catalogs it is found that this would be a 7½x5x6 size (duplex) or it might be an 8x5x10, or at a higher speed, we could select a 5¼x3½x5. This smaller size would be required to run much faster than the speed that we first selected in order to do the required work, the speed would be 30 feet per minute. We know that this is too high, but it will assist us to show the false economy of selecting either too small or too large a pump.

In the above plant we will assume that the steam pressure is 125 pounds, and that the friction in the water lines is 15 pounds making a total of 140 pounds against which the pump will have to operate. The pump horsepower that would be required for this would be found as follows:

$(15{,}000 \times 140) \div (60 \times 33{,}000 \times 0.433) = 2.5$ pump horse power.

In determining the amount of steam that will be used by this pump, we will take the volumetric displacement as the pump takes steam the whole stroke, which makes this true, as well as the reason why this type is so extravagant in steam. The 7½x5x6 pump will have to travel 15 rpm in making the 15 feet per minute as in each double stroke the pump travels one foot. The displacement will be found as follows for the steam end, or the amount of steam required to pump the water.

(a) $[(7\frac{1}{2})^2 \times 3.1416 \times 15' \times 2 \times 12'' \times 60) \div 4 \times 1728 \times 3.15) = 175$ pounds per hour.

Since this pump is doing 2.5 pump horsepower in feeding these boilers, the rate of steam per php is,

$175 \div 2.5 = 70$ pounds per hour per php.

We will now see what this steam consumption would be if we selected the smaller pump, say the 5¼x3½x5. In this case the speed of the pump would be much greater, or 30-feet or 37-rpm, to do the work. This would require for steam,

(b) $[(5\frac{1}{4})^2 \times 3.1416 \times 37 \times .833 \times 2 \times 12 \times 60] \div (4 \times 1728 \times 3.15 = 250$ pounds per hour.

or $250 \div 2.5 = 100$ pounds per hour per php.

This shows that we should not select the smaller size of pump as the waste in the steam would be too great, not to mention the high speed.

We will now see what the other size of pump will give, namely, the 8x5x10. Since in each stroke the pump piston goes 1.66 feet, the rpm will be small, or 15 ÷ 1.66 = 9 rpm.

The steam required would be,

(*c*) $[8^2 \times 3.1416 \times 9 \times 1.66 \times 2 \times 12 \times 60] \div [4 \times 1728 \times 3.15] = 198$ pounds per hour.

or 198 ÷ 2.5 = 79 pounds per hour php.

This shows this pump to be more extravagant than the 7½x5x6 pump. If we refer to the table of pump ratings, we will find that this size pump was selected as the best pump for a total of boiler horsepower from 450-horsepower to 600-horsepower.

Below a table is given showing the proper size pump to be used for different sizes of plants; the amount of steam required to operate these pumps when they have slippage from 0 per cent to 50 per cent and also the speeds and rpm for each pump at the different slippages. From this table the engineer can readily count the revolutions of his pump and tell how much slippage there is in the pump. This slippage may be in the valves or it may be around the piston. In the piston type of pump there is no way to tell where this is, but in the outside plunger type of pump this can be ascertained as the loss around the piston or rather the plungers would be on the outside.

TABLE SHOWING PUMP SLIPPAGE.

		0%		10%		20%		30%		40%		50%			
Size Pump	Boiler H. P.	Speed RPM.	Steam Per Hr.	Speed RPM.	Steam Per Hr.	Speed RPM.	Steam Per Hr.	Speed RPM.	Steam Per Hr.	Speed RPM.	Steam Per Hr.	Speed RPM.	Steam Per Hr.	Pump H. P.	Steam per P. H. P. Hour
4½ x 2¾ x 4	150	22	62	25	70	28	76	32	90	37	106	45	124	.74	84
5¼ x 3½ x 5	250	18	86	20	95	23	110	26	125	30	140	36	172	1.23	70
6 x 4 x 6	350	16	120	18	132	20	144	23	172	27	200	32	240	1.70	70
	450	21	160	24	180	26	200	30	230	35	270	43	320	2.25	72
7½ x 5 x 6	450	14	165	15	175	17	200	20	235	23	260	27	315	2.25	73
	600	18	210	20	235	22	255	25	290	30	350	36	420	3.00	70
8 x 5 x 10	600	10	230	12	270	14	305	16	360	18	390	21	460	3.00	78
	750	13	290	15	335	17	380	19	420	22	490	27	590	3.65	80
10 x 6 x 10	750	7	240	8	270	9	310	11	380	14	480	15	520	3.65	66
	1000	12	425	14	490	16	560	18	620	20	700	24	820	5.00	85
10 x 6 x 12	750	7	290	9	380	10	420	11	460	12	500	15	610	3.65	80
	1000	10	415	12	490	13	540	15	620	17	710	21	870	5.00	81
12 x 7 x 10	750	7	350	7	350	8	370	10	490	11	550	14	690	3.65	95
	1250	10	490	12	590	14	690	16	790	18	890	20	990	6.20	80
	1000	7	450	8	500	9	560	11	660	12	740	15	900	5.00	90
12 x 7 x 12	1250	9	565	10	615	12	715	13	810	15	910	19	1125	6.20	92
	1500	12	700	13	750	14	820	17	990	19	1150	23	1350	7.50	92
	1750	14	800	15	900	17	990	19	1150	22	1300	26	1550	8.75	92
	2000	15	900	17	1025	19	1150	22	1290	25	1500	30	1800	9.90	92

The above table is based on a steam pressure of 125 pounds, which has a volume of 3.15 cubic feet per pound. If the amount of steam is required for any other pressure, it may be found by multiplying the above given quantity by 3.15 and dividing the result by the volume of a pound of steam at the given pressure.

In the formulas *a*, *b* and *c*, it might be well to explain what each expression referred to as these are abstract quanties. In formula (*b*) we have,

$[(5\frac{1}{4})^2 \div 4]$ = area of the cylinder; 37 = number of revolutions the pump makes per minute, where 1 revolution = 4 strokes; .833 = the portion of one foot in every rpm and is used to change the rpm to feet per minute; 12 = inches per foot; 60 = minutes per hour; 1728 = inches in one cubic foot; and 3.15 = cubic feet to one pound of steam at 125 pounds pressure.

To those who are familiar with the use of the slide rule, I will give an easy and quick way of selecting a pump by its use.

For example, we will take the case of the 7½x5x6 pump. We know that the pump must handle 30 gallons gallons per minute for 500 horsepower. We will assume the speed of the pump to be 15 feet per minute then on the scale "A" of the slide rule at 30 set 15 on "B" under the 30. On "C" run the reading hair line to 3.5 and on "D" read 4.95, the diameter of the cylinder of the water end of the pump. This is for a duplex pump. If the case is a simplex pump then set the reading hair line at 4.95 on "C" and read the answer on "D" as above. In either case the answer gives the diameter of the water cylinder.

Since we have found the size to be about 5 inches, we know that the pump must be either the size selected above or some other size that has a 5 inch water cylinder.

The pump horsepower is worked out on a basis of there being 15 pounds friction in the boiler feed line, making a total of 140 pounds against which the pump is working instead of the actual 125 pounds steam pressure.

The figure given under the heading *steam per hour* shows the actual amount of steam that is required by the pump for actual conditions and also for the different slippages of the pump.

The heading *steam per pump horsepower hour* is based on the actual amount of steam that the pump is using without any slippage at all. This amount is obtained by dividing the amount of steam per hour by the pump horsepower.

It is a common occurrence for a pump to have 40 to 50 per cent slippage, and from this table one can readily see the loss from running a pump under these conditions. A steam pump is the most extravagant of any piece of steam machinery about a power plant, and to allow it to run with a great amount of slippage is an unnecessary waste. The reason that this type of pump uses so much steam is due to the fact that there is no cut off to the valves and the pump takes steam the full stroke. It does not matter whether the pump is doing work or not, the cylinder fills with steam and is released at the end of the stroke.

Earl F. Scott, M. E.

What is the Function of Lightning Rods?

The title of Mr. Hall's question on page 425 of the October issue of *Electrical Engineering* might have more properly been, "What Are the Functions of a Lightning Rod?" because as will be shown, the device has two materially distinct duties. We will not endeavor to answer Mr. Hall's questions in the order that he asks them, but will treat all of them in the course of the following discussion.

A lightning stroke—the thing we see in the air—is a path between a cloud and the earth, heated to incandescence by the interchange of a current of electricity at exceedingly high voltage. We do not, of course, see the electric current of the discharge; all that we see is the white-hot path that is created by the discharge current. When this white-hot path suddenly cools, the air rushes into it and then there is thunder.

What is the cause of thunder storms? No absolute proof has ever been presented as to this phenomenon, but it is fairly well agreed that thunder storms are due to the following conditions: It can be shown that points in the air at different distances from the earth are at different electrical potentials. In other words, there is a potential difference between the earth and different locations in the air. This potential difference sometimes aggregates several hundred volts per foot. A location 100 feet above the earth may sometimes be at a potential of 10,000 volts above ground. No attempt will be made to explain the reason for this condition. We merely state as a fact that the condition exists. A minute drop of moisture will assume therefore at any location in the air, the potential of that location. If a strata of air in the regions above the earth tends to become cool, the particles of watery vapor will agglomerate to form larger particles or possibly drops of moisture. Now, it is a geometric fact that if two spheres are combined to form a single sphere, the superficial area or surface of the sphere so formed will be materially less than the joint surfaces of the original two spheres. This is notwithstanding the fact that the second sphere contains twice the amount of water as the first. Now the capacity of a sphere is proportional to its diameter and since the larger drop has the charges of two particles but does not have twice the diameter of either particle, the potential of a large drop will be greater than that of either of the components. Agglomeration proceeds in this way until the potential at a certain point in a cloud is so much greater than that of other points in the cloud, or greater than that of the earth, that a lightning discharge will take place, provided the tendency to discharge is not neutralized before the stroke occurs.

The above paragraph explains how a charge of static electricity of high potential is probably developed in a cloud. This charge in the cloud will, because of its inductive effect, influence an equal but opposite charge on the portion of the earth, or on the objects on the earth, directly under it, as shown in Fig. 1. If the cloud is charged positively, a negative charge will be induced on the earth or on objects directly under the cloud. There will be a constant striving of this positive and negative charge to flow together and neutralize. This creates a tendency for a lightning discharge.

Now we will consider the first of the functions of a lightning rod. This function is due to the property, that sharp points have, of leaking or discharging high-potential electricity. It can be shown by experiment or mathematically that the electric potential at a sharp point will build up so intensely that static electricity will discharge from it. This principle was demonstrated by Benjamin Franklin in 1760, but does not yet appear to be generally understood as regards its application to lightning protection. It follows that if a pointed conducting rod is connected at its lower end with the ground, carried up a high object, so that its upper pointed end will extend in the air, that any electricity induced on the ground in the neighborhood of the conductor will tend to discharge from the point at its top, as shown in Fig. 2. The conductor should not be insulated from, but should be attached directly to, the building that it protects. This discharging action will or will tend to neutralize the potentials between the earth below and the cloud above, and thus endeavor to prevent a light-

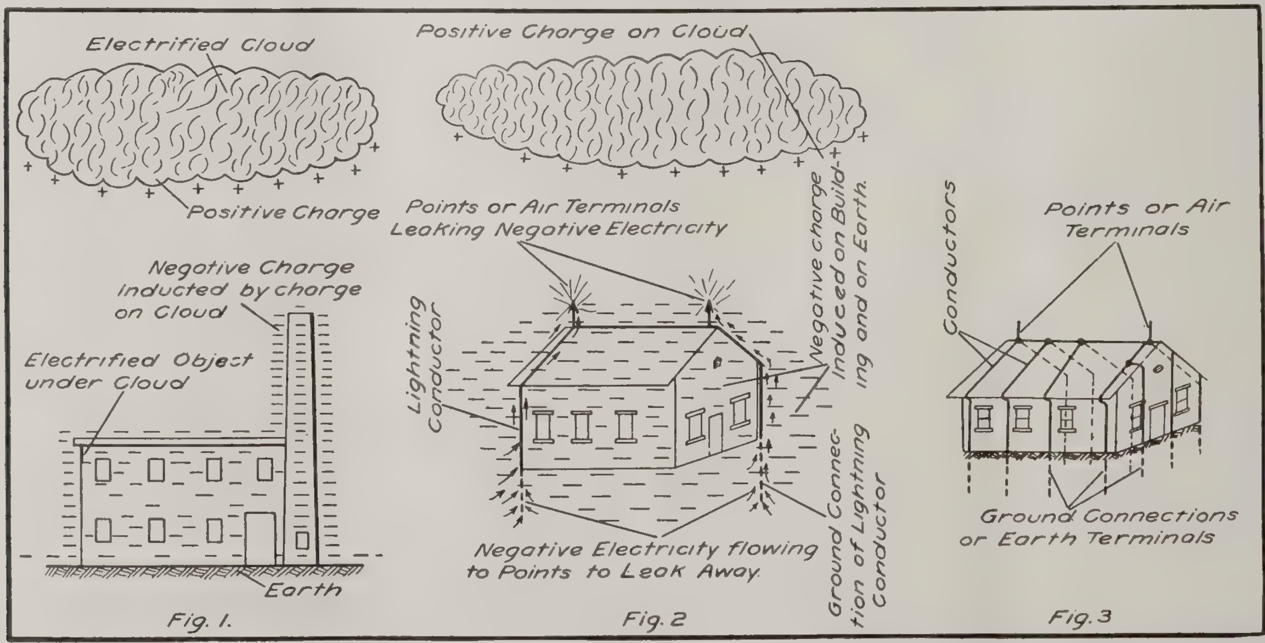

Electrified Cloud
Positive Charge
Negative Charge Inducted by charge on Cloud
Electrified Object under Cloud
Earth
Fig. 1.
Positive Charge on Cloud
Points or Air Terminals Leaking Negative Electricity
Lightning Conductor
Negative charge Induced on Building and on Earth
Ground Connection of Lightning Conductor
Negative Electricity flowing to Points to Leak Away
Fig. 2
Conductors
Points or Air Terminals
Ground Connections or Earth Terminals
Fig. 3

Fig. 1. Conditions Preceding a Lightning Flash. Fig. 2. Points Leaking High Tension Electricity and Tending to Prevent a Lightning Stroke. Fig. 3. Building Enclosed in a Conducting Cage, a Discovery of Faraday.

ning discharge. The first and most important function of a lightning rod, then, is to prevent discharges through the leaking action of points.

Sometimes, however, the potential of a cloud will build up so rapidly that it is impossible for the point action of a lightning conductor to neutralize it. In this case a discharge must necessarily occur, and then the function of the lightning rod is to complete a path of minimum opposition between the air and the earth for the lightning discharge to follow. The lightning conductor should enshroud the building that it is to protect as completely as possible as shown in Fig. 2. A grounded metal cage, Fig. 3, or metal sheath enclosing a building should theoretically afford absolute protection. The ground connection must be good.

There appears to be no particular basis for the statement "that lightning seldom strikes twice in the same place" because it can be shown by an almost unlimited number of examples, that lightning has not struck only once, but repeatedly, in the same place. For instance, the Washington monument in Washington, D. C., the Eiffel Tower in Paris, and the White House, in Washington, have all been struck more than once. The Washington Monument and the Eiffel Tower, have, we understand, been struck a great many times, but without any appreciable damage because the Eiffel Tower is of itself a splendid lightning rod, and an elaborate system of rodding protects the Washington Monument.

The advertisement that accompanies Mr. Hall's question probably contains misinformation. It used to be held by some scientists that the atmospheric electricity that produces thunder storms was generated by the friction of the air on the earth as it revolves, and by the wind blowing over objects on the earth. Some physicists also maintained that atmospheric electricity was due to charged globules of moisture rising from the ocean and other bodies of water. It now appears to be fairly generally held, however, that the enormous differences of potential in the clouds are created through the agglomeration of moisture particles as indicated in the above paragraph. While it is altogether probable that wind blowing through grain may develop some static electricity, we do not believe that this phenomenon has anything to do with thunder storms.

Regarding the effectiveness of correctly installed lightning rods, there is now absolutely no question. Statistics compiled by the fire insurance companies in certain states where the fire losses due to lightning used to be enormous, show that a properly rodded building although it may be struck, will practically never be damaged by lightning. For some reason or other that has never been satisfactorily explained lightning shows a tendency to strike hay stacks and barns that are filled with hay. In some communities, portable lightning rod systems are installed over hay stacks. Barns should be rodded.

Terrell Croft.

Causes of Lightning Supplementing Mr. Croft's Remarks.

Supplementing the comments by Mr. Croft on the causes of lightning and to bring out a few points he did not take up, we quote what follows from an address by Dr. C. P. Steinmetz on the subject of lightning phenomena, delivered before a joint meeting of the Franklin Institute and the A. I. E. E. Dr. Steinmetz said:

"With our present knowledge, we must consider as the most probable explanation—although not certain by any means—that the lightning discharge is the phenomenon of the equalization of internal electric stresses in the cloud, and is analagous to the splintering or breaking of an unevenly stressed brittle material, like glass. The question then is, how do these uneven electrostatic stresses originate in the cloud, and how do they reach such values as to cause internal equalization by rupture? If there has been produced a very highly unequal distribution of voltage in the electrostatic field of the cloud, it is easy to see how a discharge can pass along miles of cloud, without such unreasonably great potential differences as would be required for a direct discharge across space, just as from a scratch in a poorly annealed glass plate, cracks may run all over the plate, splintering it in all directions. Assuming that the potential distribution in the cloud becomes very uneven, if then at some point the potential gradient becomes higher than the disruptive strength of air, at this point a local disruptive discharge occurs, perhaps only a few inches in length. This discharge equalizes the potential gradient within its path, and thereby increases the gradient at the ends of the discharge.

"It is not so difficult at least to make a preliminary estimate of the building up to very high, and uneven voltage distribution in the cloud, as soon as you have assumed some initial voltage. We do not know where the initial voltage comes from, but we must accept the fact that there is normally a voltage gradient in the air, a potential difference between different altitudes which may amount to a hundred volts or more per foot.

"If condensation takes place in the higher regions of the atmosphere, rain drops form, minute drops at first, which necessarily must be at the potential of the air in which they form. This means they have a potential difference against the ground, and therefore an electrostatic charge against the ground, corresponding to this potential difference. Assuming now that many of these minute raindrops conglomerate to larger drops, it means that many small condensers conglomerate to one condenser, which is somewhat larger in capacity, than each component, but very much smaller in capacity than the sum of the capacities of its components. But it contains all the electrostatic charges of the rain-drops, and at the much smaller capacity, the same charge gives a higher potential difference: Suppose a thousand small rain-drops conglomerate into one large one. This has ten times the capacity but 1000 times times the charge, hence a hundred times the voltage. Conglomeration of minute drops into larger ones thus must give a great increase of potential difference against ground.

"We know the clouds are not uniform in density, and where the density is greatest conglomeration of condensed drops takes place to a much greater extent, building up to a much higher voltage, and thereby between the parts of the clouds of different density, the light and the dark portions, potential differences must appear and increase with increasing condensation, until somewhere the disruptive gradient is passed, equalization occurs by a lightning discharge, and then the same play repeats again and again.

"Lightning discharges then are the result of the voltage unequalities produced in the clouds by the unequal rate of conglomeration of rain particles due to the unequal cloud density. In agreement with this is, heavy lightning strokes are usually followed by a heavy down-pour of rain. In reality they are preceded and caused by it, but it takes time for the rain-drops to come down.

"Let us assume now that the process is reversed, and after conglomerating to high voltages the rain-drops evaporate again. Since gases apparently do not carry electrostatic charges, the rapidly dwindling rain-drop retains its entire charge, hence must rise in potential, and finally must discharge, and this progressive evaporation of the rain-drops must also result in the building up of potential differences and therefore the formation of lightning, and this may explain the two forms of lightning, that accompanying rain-storms and thunder storms and the so-called 'heat' lightning.

"The former is the result of condensation and conglomeration, the latter the result of evaporation of rain-drops. In this field, which is not merely of theoretical interest, but of high industrial and general importance, our knowledge is still very limited. It is a fairly unexplored field of electrical engineering and electrical science."

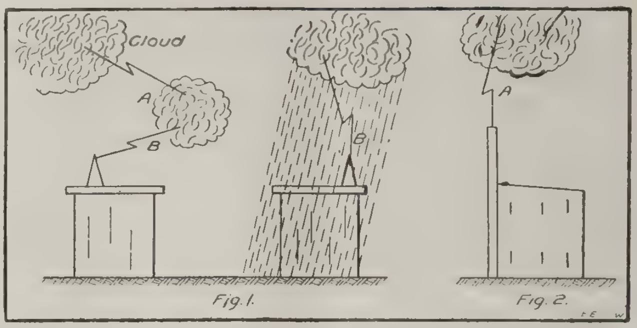
In answer to the question as to the advisability of using ordinary lightning rods for the protection of buildings and high exposed points of structures, Dr. Steinmetz also said: "The lightning rod is a great protection and I would not like to be in an exposed place without such protection. But you must not expect that one rod on one end of the building will completely protect the other end a hundred or more feet away. There must be sufficient rods to extend their protective zone over the entire area. The apex of the roof and other projecting edges must be protected by connecting wires, etc. That is, like any other apparatus, the lightning rod protection must be installed intelligently and properly to be effective. The general principle is correct only it must be rationally applied."

It may be of interest to mention that a paper giving investigations to determine a suitable system of lightning protection for buildings containing explosives, was presented by L. A. DeBlois at the Washington meeting of the A. I. E. E. last April and published in the proceedings of the Institute for April. An interesting discussion of this paper has also been published and is found in the October issue of the proceedings. Comments by Dr. E. E. F. Creighton, Prof. Elihu Thomson, Dr. George R. Olshausen and others are given taking up the scientific features of the subject which will be of interest to any reader who desires to make it a study.—Editor.

Causes of Lightning Phenomena.

It is the general opinion among a large percentage of the people that lightning is a ball of fire, which either strikes some object or buries itself in the ground: no thought is given to the cause. This opinion is wrong. Lightning is caused by a potential difference or difference in voltage which exists between the clouds and the earth. The earth is a partial conductor, over it is atmosphere which is a very good insulator, further out is the rarefied air which is a partial conductor. There is no bolt of lightning: Since heated air has a lower resistance than cold air, and electricity always follows the path of least resistance, we have the frequently seen zig-zag flashes, the air being a mixture of warm and cool strata,

The reason for houses, trees, chimneys, etc., being struck, or, rather having the electricity pass through them, is that they project up in the air, decreasing the length of the high resistance air, being better conductors than the air the electricity naturally follows this path to the earth. The flash of lightning which we see is that of a column of intensely heated air, caused by the electric current passing through it, driven out from the path of discharge at a velocity of about 186,000 miles per second.



Diagrams Showing Nature of Lightning Phenomena.

Ball and sheet lightning are caused by flashes which occur between clouds. Clouds often become charged at different potentials, and flashes result between them as between clouds and the earth.

There are two kinds of lightning discharges, and buildings should be protected from both. One is discharge by steady strain (A). The other is discharge by impulsive rush (B). These are shown in figures 1 and 2. A is when the lightning passes directly from a cloud to the earth. B is when it passes first from one cloud to another, and then from this cloud to the earth. B also occurs when it suddenly rains. Rain is of lower resistance than air, and the lightning therefore passes with a sudden impulse to the earth.

Modern methods of protection against lightning take both types of flashes into account. The only complete protection against a B flash is a bird-cage construction of metal around the building, and this must be well grounded. To effectively guard against the A flashes the common lightning rod can be used, but with the following precautions:

The rods should be pointed and well insulated from the building; they should be effectively connected with the ground; they should be good conductors, so as not to be injured by a powerful discharge; there should be enough rods to project beyond all salient parts of the building. Lightning rods can be very well grounded by connecting them to water pipes, but, for "safety first," never with gas pipes. In rural districts they can be buried deep in moist ground. Experiments have shown that rods should be either of one inch diameter iron or three-eighths inch diameter copper. For equal lengths these have the same resistance, but iron is preferable for it has greater heat-radiating area.

A building well surrounded by tall trees is quite immune from both types of flashes. Buildings of concrete construction, with their iron frame works well tied together, are very well protected against all lightning. Since heated air is a comparatively good conductor of electricity, it is useless to put rods on large chimneys, for lightning will pass to the earth by way of the heated air.

It is not true that lightning never strikes in the same place twice. It is not liable to strike the same place twice during a certain storm, for the clouds in one place are usually discharged at the first flash; but charges may exist and lightning strike the same place during any later storm.

In the above discussions on the causes of lightning no attempt has been made to cover the subject thoroughly or in a truly scientific manner. Only the very fundamentals are used. For more advanced information the reader is referred to the following references: Steinmetz: General Lectures on Electrical Engineering; Lodge: Lightning Conductors and Lightning Guards; Rowland: Atmospheric Electricity.

Howard R. Smith.

Causes of Lightning.

Static electricity is caused by friction, positive potential being stored in atmospheric moisture and negative potential in the earth. When potential between atmosphere and earth becomes large enough, rupture takes place from the nearest conductors. Hence, even though the wind generated a negative current, it would be stored in the earth, and not on growing wheat except as the grain was higher than the earth. Storing in a barn would not make the barn any more liable to be struck than if it contained sheep. The barn would be liable to be struck from the fact that it was high and thus nearer the charge. Height and conductivity determine where lightning will strike.

J. H. Ross.

Questions and Answers from Readers

Readers are invited to make liberal use of this department for discussing questions, obtaining information, opinions or experiences from other readers. Discussions and criticisms on answers to questions are solicited. However, editors are not responsible for correctness of statements of opinion or fact in discussions. All published answers and discussions are paid for.

Strength of Insulators vs. Pins.

Editor Electrical Engineering:

(486) Please advise which gives way first under load a wood pin or its insulator at voltages say 11,000 to 44,000, due to bending stresses and side pull. How do metal pins and the same type of insulators act under same conditions? The writer understands that the leakage at the voltages mentioned over the insulator to the pin may in some cases be enough to char or burn the pin. Could this action be responsible for failure at pin and insulator rather than the load stresses? W. T. R.

Grounding Secondaries.

Editor Electrical Engineering:

(487) Please explain through your columns the best practice in grounding secondaries. Show where to ground and give connections, sizes of wire to use and any precautions to be observed. L. W. F.

Causes of Sparking of D. C. Generator.

Editor Electrical Engineering:

(488) I have charge of a 150 kw. 250 volt six pole, D. C. generator which gives considerable trouble from sparking. The commutator has been turned down four times in the past six months and the brushes carefully fitted and equally shocked. It will run for a few days without sparking, when it will begin to spark at alternate brushes, that is the negative brushes will show sparking and three black spots begin to show up equally spaced around the commutator. The armature is wave wound and the fields have been tested by the voltage drop method and found to be OK. We have other machines of the same type that give perfect satisfaction. I would like to get opinions on this trouble from readers of *Electrical Engineering.* C. A. H.

Determining Power Taken by Machine.

Editor Electrical Engineering:

(489) The writer desires to make some tests on motor driven machines such as drill presses, lathes, etc., to determine the power consumed in their operation. I would like some reader to outline the nature of test required to secure as accurate data as possible. About how much current should a 10 horsepower 220 volt induction motor take when running without load and revolving its rotor only?

C. D. B.

Calculation of Inductance in Coiled Circuits.

Editor Electrical Engineering:

(490) The writer would like to see in the question and answer department a discussion on how to calculate inductance of coiled circuits both with and without iron. Any formula given should be simple and plainly understood.

T. E. T.

Connections of Two-Phase Alternators.

Editor Electrical Engineering:

(491) Would it be practicable to interconnect the windings of a two-phase generator in T to secure three-phase and at the same time operate two-phase motors as already installed and originally connected? That is can both two and three-phase current be taken from two-phase generators by the use of a T connection? T. E. T.

Convenient Resistances, Ans. Ques. No. 456.

Editor Electrical Engineering:

A simple, flexible and easily constructed resistance may be made from a number of keyless lamp receptacles and some single pole, double throw knife switches. Mount the receptacles on a board on a straight line and connect them all in series. Mount the switches at each end and between each two lamps. The center contacts should be connected in the wires from lamp to lamp as shown. The outer contacts are then connected all together and brought out to terminals. Referring to Fig. 1, by throwing No. 1 to right and No. 7 to left, we have the whole bank in series. By throwing No. 1 to right No. 2 to left, No. 3 to right, etc., we can have the whole bank in parallel. We can also obtain any combination in between. For instance the diagram shows connections of four lamps in series and four sets of four in multiple. By opening and closing adjacent

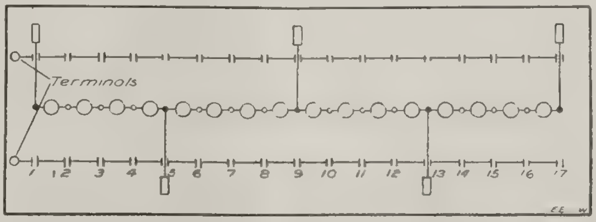


Fig. 1 Arrangement of Lamps for Resistance.

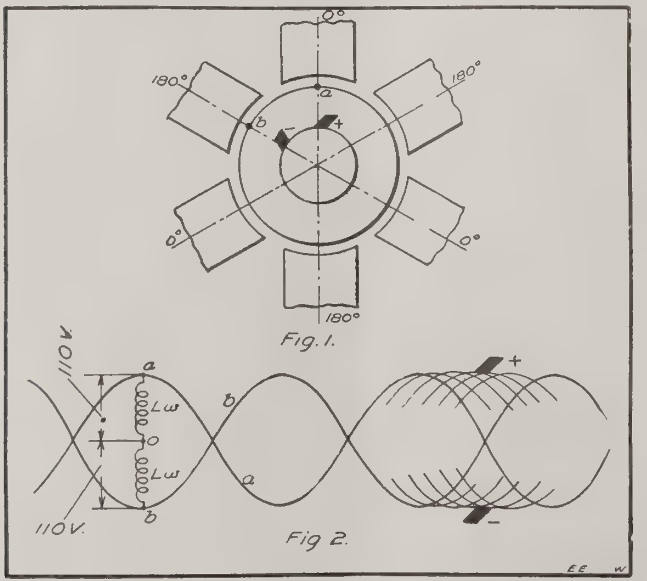
switches, very fine adjustments can be secured. The hot resistance, using 16, 16-c.d. lamps can be varied from 14 to 3520, with corresponding changes in current and voltage ranges. Evidently about 800 watts can be taken care of. Using 32 c.p lamps will double the capacity. Coils of wire can be made up on the same principle if lamps will not meet the requirements.

Repairing Electric Fans. Ans. Ques. No. 460.

The fan motor armature is a small piece of apparatus and when it goes wrong it generally goes wrong all over There is not much need for locating bad coils. Fan armatures are usually hand wound and any open or short usually necessitates a complete rewinding. In testing, one should have a test line, which is simply a lamp circuit with a pair of terminals in series. The armature may be taken out and voltage applied to the fields. If they are normal, the light will burn dim. If short, it will burn bright. If open, will not burn at all. Practice will soon enable an operator to recognize normal field. Double voltage may then be put on field, and between field and frame to detect any other faults. The armature may now be inserted, and tried out. If it sparks at the commutator, it may be due to poor brushes or rough commutator. After putting in new brushes and turning off commutator, it may be tried again, and if sparking still takes place, there is an open circuit somewhere in the winding. Sometimes this may be repaired, but more often the armature must be rewound.

Connections for Changing 2-Wire Generator to 3-Wire. Ans. Ques. No. 468.

Connections referred to in question No. 468 are known as the Scott 3-wire system using balancer coils and was introduced by Mr. C. F. Scott of the Westinghouse Electric & Manufacturing Company. Fig. 1 shows two conductors A and B in an armature rotating in a six pole field. Fig. 2 shows the voltage curves for these conductors, marked (a) and (b) respectively. It will be noted that these voltage values are always exactly equal and opposite in respect to a neutral axis. If therefore the conductors (a) and (b) be connected by an inductive resistance, a small alternating current will flow through this resistance and the central point (o) will always be at the same potential. For instance if the machine generates 220 volts and the current is collected from two brushes located at the points of maximum potential, there will be a steady voltage of 110 volts from (o) to both the (+) and (—) brushes.



Figs. 1 and 2. Showing 3-Wire System Using Balancer Coils.

Protection for Feeders vs. Generators. Ans. Ques. No. 471.

Protective devices are of more use in the feeder than in the generator circuits because trouble on the line is more definitely located and disposed of. Busbars are divided into short sections, each fed by one to three generators, and each having several feeders. These sections are connected by reactances. Under normal conditions comparatively little current passes through these reactances, but in case of a short circuit on any feeder, the inrush of current from the other sections is limited, enabling the protective device to take care of the overload. The machinery itself is not in need of protection, as most large A. C. machinery will not develop more than 2 or 3 times full load current even on short circuit, due to internal reactance, and in case of trouble it can be easily cut out from the switchboard without danger. A. G. Rakestraw.

Calculating Flux of a Magnet. Ans. Ques. No. 475.

Editor Electrical Engineering:

The determination of the flux resulting in an iron circuit from a given number of ampere-turns or the ampere-turns required to produce a desired flux, may be best made by use of this equation.

$1.257\ A\ T = HL$, where $1.257 = 4/10\ \pi$; A = amperes; T = turns; H = magnetization force (in gausses) and L = length in centimeters. This formula might be stated as follows: The M. M. F. or magnetic potential applied to a magnetic circuit equals the fall of magnetic potential around the circuit.

In order to use this equation in solving a problem when ampere turns are known and flux is required, compute H, then from a B-H curve, determine B for the kind of iron used, and multiply this by the total section to get the flux repuired. B is the flux intensity (in gausses) or the flux per square centimeter.

It might be noted in connection with practical problems that from the formula $1.257AT = HL$, the flux of a circuit (leakage neglected) is independent of the location of the M.M.F. of the circuit, independent of the diameter of the turns of winding, and of the size wire used. It is also unimportant how AT is made up, *i.e.*, few turns and high current, or many turns and low current.

In this problem, L = 1 inch = 2.54 cm; A = 1 ampere; section = $1 \times 1\frac{3}{8}$ sq. in. = 8.88 sq. cm.; T will have to be calculated, assuming the length of spool is one inch and wire is single cotton covered (for No. 21 = 30.7 wires per inch). Then 50 feet of this wire gives about 110 turns.

Substituting in the above formula,

$$1.257 \times 1 \times 110 = H \times 2.54.$$

Solving for H, equals 54.5 gausses per centimeter. Assuming the core is of cast iron, we obtain from a B-H curve a value of B equal to 7,200 gausses of magnetic induction. This value multiplied by the cross section, $7{,}200 \times 8.88$, gives 64,000 for the total flux.

The "Syllabus on the Magnetic Circuit," published by Dr. A. J. Rowland of Drexel Institute, Philadelphia, Pa., gives a very clear explanation of the above formula, its deviation, etc. H. R. Smith.

Derivation of Wiring Formula. Ans. Ques. No. 478.

Editor Electrical Engineering:

In question 478 of the September issue, E. F. S is trying to use a formula designed for rough calculation, such as one meets in inside wiring, to check up with another, more accurate one, for line transmission problems. Either formula is correct in its own limiting sphere of service. Bringing these formulas down to the same notation we have,

(1) $\text{C.M.} = (\text{hp.} \times 746 \times D \times K \times 1.5) \div (n \times pf \times E \times e)$, and,

(2) $\text{C.M.} = (W \times D \times K_1) \div (E^2 \times P)$.

To bring the power terms together we have:

(3) $W = (\text{hp.} \times 746) \div (n \times pf)$

Equation (1) can then be written,

(1a). $\text{C.M.} = (W \times D \times K \times 1.5) \div (E \times e)$.

Before continuing further, suppose that we clear up several differences in these formulas. It is noted that a numerical constant (1.5) appears in (1), that is absent in (2). This is for overload starting allowance, as stated in the Standard Handbook for Electrical Engineers (sec. 18 paragraphs 50, 53 and 65). This allowance is required in inside work but is unnecessary on line transmission, hence, for purposes of comparing (1) and (2), we can drop the 1.5. It is noted that K_1 is nearly 100 times K. This is because P is expressed as a percentage instead of a fraction. If P is expressed as a fraction, then $K_1 = K$, nearly. The difference is due to the resistance of a mil-foot of copper being taken as 11 ohms in one and 10.8 ohms in the other. The allowance for change in (pf) has not been made the same in each case. Suppose, for purpose of comparison that $K_1 = K$, and that the resistance of a mil-foot of copper is 11 ohms. Then (1a) and (2) become,

(4) $\text{C.M.} = (W \times D \times K) \div (E \times e)$, and

(5) $\text{C.M.} = (W \times D \times K) \div (E^2 \times p)$, where in (5), $p = P \div 100$.

With the problem given,

(W) in (3) $= 20 \times 746) \div 0.88 \times 0.80 = 21{,}200$ watts.

In working the second case E.F.S. uses,

$W = (\sqrt{3} \times 220 \times 51 \times 0.8) \div 0.88 = 17{,}700$ watts.

Where he gets his 51 amperes he does not state, but, it is clearly seen that he is using an entirely different set of power values for each case. For our purpose we can assume either value, take then, 21,200 watts. Then (e) is given in the problem as 3 volts. And in case (2) E.F.S. uses p = 1.2 per cent. These do not work out the same, as

(6) $e = (PEM) \div 100$.

Where M is a constant, taking account of power factor, frequency and size wire. In our case M = 100, hence, e $e = 3 = (p \times 220 \times 1.00) \div 100$, and $p = 1.37$ nearly.

Then,

(4). $\text{C.M.} = (21{,}200 \times 40 \times 17) \div (220 \times 3) = 21{,}800$.

(5). $\text{C.M.} = (21{,}200 \times 40 \times 17) \div (220^2 \times 1.37) = 21{,}800$.

I hope from the above that E. F. S. can see that the formulas are correct within their respective limits. Now, to derive (2). After reading carefully sec. 18, par. 49 of the Standard Handbook, assume the following well known D. C. formula, namely:

(a). $\text{C.M.} = (22 \times D \times I) \div e$, since $W \div E = I$ and $e = (P \times W) \div 100 \times I$, then (a) can be written:

$\text{C.M.} = [22 \times D \times (W \div E)] \div [(P \times W) \div 100 \times I)] = 22 \times D \times W \times 100 \times I) \div (E \times P \times W) = (22 \times D \times W \times 100 \times W) \div (E \times E \times P \times W)$.

Now 22 and 100 = K and cancel. Then,

$\text{C.M.} = (K \times D \times W) \div (E^2 \times P)$; (b), where K = 2,200 for D.C., and on account of the copper required ratios, 1,100 for two and three-phase A.C., at unity power factor.

The values of K are more or less different in books because of the fact that it is open somewhat to a man's own judgment as to how much to allow for variation in pf, etc. I have used a set of values as given below with good success.

Value K in (b).	Conditions.
2,400	Single phase all lights.
3,000	Single phase lights and motors.
3,380	Single phase all motors.
1,200	3 ph. 3 wire 2 ph. 4 wire all lights.
1,500	3 ph. 3 wire 2 ph. 4 wire lights and motors
1,690	3 ph. 3 wire 2 ph. 4 wire all motors.

H. E. Weightman.

Derivation of Wiring Formula. Ans. Ques. No. 478.

Editor Electrical Engineering:

If E. F. S. will refer to the Standard Handbook for Electrical Engineers, he will find that the formula given allows for 50 per cent overload. This comes in as the factor 1.5 in the formula.

The derivation of the second formula given by F. A. T. is as follows: Where, W = power in the circuit; E = line voltage; I = line current; P = power factor; K_1 = factor depending on number of phases (for 3-phase it is $\sqrt{3}$); L = loss in line (actual); R = resistance per line; K_2 = number of wires used; Y = L/W = % line loss; p = specific resistance of copper in ohms per mil foot; = 10.8 at 31°C; A = area of conductor in circular mils; D = distance of transmission.

Then, $K = (10.8\ K_2) \div (K_1^2\ P^2)$.

$W = K_1\ E\ I\ P$. Therefore, $I = W \div K_1\ E\ P)$

Power loss in this line will be,

$L = K_2\ I^2\ R = K_2\ R\ [W^2 \div (\ K_1^2\ E^2\ P^2)]$

Also, $Y = L \div W = K_2\ R\ [W \div (K_1^2\ E^2\ P^2)]$

$R = p\ D \div A = (10.8\ D \div A$ at 31° C.

Then $Y = 10.8\ K_2\ D\ [W \div (K_1^2\ E^2\ P^2\ A)]$ and $A = [(10.8\ K_2) \div K_1^2\ P^2] \times [W\ D \div E^2\ Y]$

But, $K = (10.8\ K_2) \div (K_1^2\ P^2)$

Therefore, $A = (K\ W\ D) \div (E^2\ y)$

R. H. Willard.

Power Demand of Electric Hoist. Ans. Ques. Nos. 469 and 480.

Editor Electrical Engineering:

The following will answer the question by Mr. F. C. Deweese in the August and October issues, Nos. 469 and 480. The data used is taken from question 480 of the October issue. If the hoisting cable were parallel to the incline as shown in Fig. 1, then by neglecting friction, the pull required to move the weight of the car (W) up the incline with a 10 per cent grade would be ($w \sin \phi$ where (ϕ) is the angle made by the incline with the horizontal.

The cable drum revolves as follows where the motor runs at 700 rpm and the gears arranged as shown in the illustration of question 480.

$(700 \times 13 \times 14 \times 21) \div (46 \times 86 \times 105) = 6.44$ rpm.

The pull of the drum in horsepower is equal to the tension in the cable times the distance the car moves through per minute divided by 33,000 or equals the weight of the car and load times the vertical distance it is moved through in going up the incline per minute divided by 33,000. By neglecting friction and calling P = to tension in the cable and D the distance the car moves per minute, with W the weight of the car and load and *d* (equivalent to D sin Θ) the vertical rise of the car per minute, then the horsepower required at the drum is,

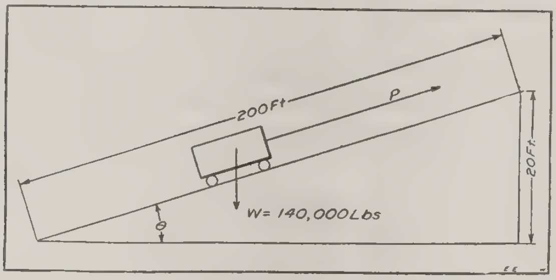


Diagram Showing Power Required to Move Car on an Incline.

$$Hp. = PD \div 33{,}000 = Wd \div 33{,}000.$$

In the case W = 140,000 pounds and d = D sin Θ where D = π 2 rn and (2r) is diameter of drum and (n) its rpm. Sin ϕ = height of incline divided by length = 20 ÷ 200 = 0.1.

$Hp. = WD \sin \phi \div 33{,}000$

$= (140{,}000 \times 3.1416 \times 24.5 \times 6.44 \times 0.1) \div 33{,}000 \times 12 = 17.5$

If the 30 horsepower motor is loaded to capacity in hoisting the loaded car up the incline, then the efficiency of gear train is 17.5 ÷ 30 = 58.5%.

This is approximately correct since Mr. Deweese says the motor takes 75 amps motor load, the ampere per terminal rating of a 30 horsepower 220 volt motor being 77.0.

F. G. Flickinger.

Calculation of Flux of Magnets. Ans. Ques. No. 475.

Editor Electrical Engineering:

The fundamental law on which all magnetic calculations are based is M ÷ R = F. Where F = flux; M = magneto — motive force; and R = reluctance.

The magneto — motive force, M = 4 π NI, where N = number of turns and I = current in absolute units = C/10 where C is current in amperes.

The reluctance, R = E ÷ p × q, where p is permeability; q, cross section of iron in sq. cm.; and E is length of iron in cm.

Then, F = (M × p × q) ÷ E.

In the problem submitted, Mr. Hafner states that the coil is on a 110 volt circuit. The resistance of 50 feet of No. 21 wire is about 0.641 ohms. The current would then be 110 ÷ 0.641 = 172 amperes. From this I assume that the necessary resistance is placed in series with the coil to bring the current value to 1 ampere. In order to calculate the flux it is necessary to know the kind of iron the core is made of. This I assume to be cast iron. If we know the permeability at which the iron is to be worked we may apply this above formula directly. However, where we have all the data given in the problem submitted it is simpler to obtain the value of flux from a characteristic magnetization curve. This is the method by which I have solved the problem.

The curve used in the following calculations is shown on page 231 of the Standard Hand-book for Electrical Engineers. I have used this curve merely to illustrate the method of solving the problem and because I believe it is most readily available to all readers.

From the data given in question 475 we have: Length of core = 1 inch or 2.54 Cm.; section of core = 1.0 inch × 1.375 inch = (2.54 × 1.0 Cm) × (2.54 × 1.375 Cm) = 8.87 sq. cm.; Length of winding = 50 feet × 12 × 2.54 Cm. = 1523 Cm.; Current = 1 amp.

The circumference of core or length of 1 turn = (2.54 × 2) + (2.54 × 1.375 × 2) = (5.08 × 6.98) = 12.06 Cm. The number of turns = 1523 ÷ 12.06 = 126.

Since the mean length of a turn is slightly greater than the circumference of the core, the number of turns as calculated above is probably one or two turns too great. However, I have used this as an approximate value. The number of turns per (cm.) of length will be 126 ÷ 2.54 = 49.6. The amp. turns will be 1 × 49.6.

From the magnetization curve for cast iron referred to above we find that with 49.6 amp. turns per cm. we will have a flux density of 7300 lines per sq. cm.

Then, 7300 × 8.87 = 64700 lines which is the value of the flux.

We may now check back and find a value for the permeability.

This we find is an average value for the permeability of cast iron when worked at such a high flux density and consequently checks our value for the total flux.

J. J. Kojan.

Why Generator Burned Out. Ans. Ques. No. 479.

Editor Electrical Engineering:

In answer to question No. 479 in the September issue of Electrical Engineering by F. A. T., regarding the burning out of a generator, it would seem that one or both phases are overloaded since the maximum terminal current at 2200 volts is 13.6 amps. The unbalanced load mentioned may be the cause of excessive surges during switching. It would be advisable to measure the insulation resistance of the machine by use of a high voltage direct current and direct deflection method. Also try to even up the load on the phases and be sure that the machines are not overloaded. If the above is done and the insulation is shown to be good, there must be a connection trouble or a wrong design used in the rewinding mentioned.

H. E. Weightman.

Why Field Coils are Connected Ahead of Armature Coils in Street Railway Motors. Ans. Ques. No. 482.

Editor Electrical Engineering:

Series direct current motors are connected so that the current will first pass through fields and then through armature when fields are connected "ahead." By this method the fields will receive the current first and set up lines of force through the armature, thus tending to rotate the armature. With the current going through the armature first there are no lines in the fields, or but weak lines, hence there would not be the power at beginning of revolution.

J. H. Ross.

Power Demand of Electric Hoist. Ans. Ques. No. 481.

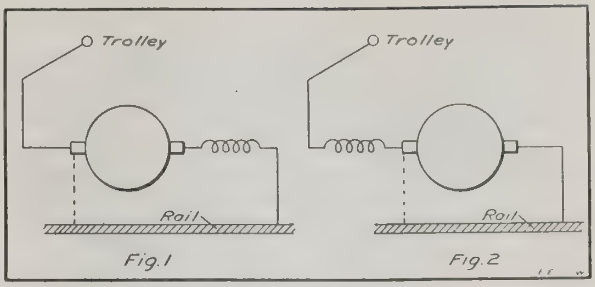
Editor Electrical Engineering:

The tractive effort or force required to pull a car up a grade is 20 pounds per ton for each per cent of grade. The grade given is 10 per cent so we get 200 pounds per ton required to pull up the grade. In addition to this we have the friction of the car which can be assumed to be about 6 pounds per ton for a car of this size going at slow speeds. Taking this into account there will be 206 pounds per ton required to pull the car up the grade. The car weighs 70 tons so the pull required is $206 \times 70 = 14420$ pounds. The speed at which the car moves is equal to the rim speed of the drum if the rope diameter is added to the drum diameter when we figure its speed. This gives us,

Speed $= [\pi(24\frac{1}{2} \times \frac{7}{8}) \times 6.44] \div 12 = 42.2$ feet per minute.

H. P. $=$ (Pull $\times$ Speed) $\div 33{,}000 = (14{,}420 \times 42.2) \div 33{,}000 = 18.5$ H. P.

The current taken by the motor is of no use in the calculation as the power given out by the motor depends not only on the current and voltage but also on the power factor and motor efficiency. The gear efficiency also effects the amount of power which the motor supplies but lost before it gets to the drum.



FIGS. 1 AND 2. CONNECTIONS OF FIELDS FOR RAILWAY MOTORS.

Field Coils Connected Ahead of Armature Coils in Railway Motors. Ans. Ques. No. 482.

The two methods of connecting direct current railway motors are shown in Figs. 1 and 2. In Fig. 2 the field is connected ahead of the armature. The advantage of this connection is that in case of lightning the field acts as a choke coil to protect the armature. This connection has several disadvantages. The insulation stress between field coil and frame of the motor is much greater than in Fig. 1 as the voltage drop across the armature is such a large proportion of the total voltage drop across the motor.

Another disadvantage of the connection shown in Fig. 2 is in case of flash over. This takes place either between brushes or from the positive brush to ground as shown by the dotted lines in the figures. With field connected ahead of the armature, the armature is short circuited by the flash while running in a strong field; this causes a violent braking action likely to be destructive to gears. In Fig. 1 the field is cut off from the line so this braking action does not occur.

R. H. Willard.

New Apparatus and Appliances

The Edison Telescribe.

It is within the memory of many of us that Bell stirred the world at the Centennial Exhibition in 1876 with his speaking telephone, and only two years later that Edison produced the phonograph—a machine that talked. Probably if it had not been for the work Edison did in the invention of the telephone transmitter shortly after 1876, the phonograph would not have come so soon, for it was Edison's experience with the diaphragm action in the telephone that suggested the recording possibilities of a diaphragm vibrating on tin foil. This close connection of experiments on the telephone and the phonograph shows itself in the first article Edison himself wrote on the latter invention, which appeared in the North American Review in 1878.

With prophetic insight into the future application of the phonograph, he enumerated ten uses it would have. Present day utilities fulfill all of these forecasts, except the tenth use, expressed by Edison at that time as follows: "Lastly, and in quite another direction, the phonograph will perfect the telephone. That useful invention is now restricted in its field of operation by reason of the fact that it is a means of communication which leaves no record of its transactions." The "Telescribe," Edison's last accomplishment, completes his predictions, made in '78, for this use of the phonograph. It is of some satisfaction, and certainly very fitting, that this combination of telephone and phonograph has been left for Edison to accomplish. That it has been no easy matter is best appreciated by the reflection that no one has done it before, although it must be evident how valuable its use promises to be.

The Edison Telescribe comprises an Edison dictating machine which is especially equipped with the telephone recording appliances. The dictating machine is equipped

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MR. EDISON USING HIS NEW INVENTION—THE TELESCRIBE.

with a micro-recorder, which swivels into place over the wax cylinder, and is wired up with the Telescribe on the user's desk. In short, the Telescribe is a complete telephone extension, run with its own small batteries concealed in the casing. A telephone message is telescribed in the following manner: The receiver of the regular-desk telephone is removed from the hook and placed in the socket of the Telescribe. In this way the accoustic connection to the dictating machine is made without danger of criticism from the telephone company, as the instrument is neither mechanically nor electrically connected to their lines. The user then takes up a small receiver, which is a part of the Telescribe, and gives his call to the exchange, while starting and stopping the dictating machine by means of two small buttons on the Telescribe in order to record the conversation between panses or delays, thus avoiding any waste of running the wax cylinder meanwhile. In this way, both sides of the telephone conversation are recorded, including all the central operator's voice in making connection.

There are many telephone subscribers in every locality who have monthly toll-bills of hundreds of dollars, evidencing the practice of conducting an important part of their business by "conversation." Brokers, in many instances, do buying and selling by telephone from both local and outlying territory; advertising agents secure the approval of their clients at distant points by reading late copy over the 'phone; purchasing agents place orders and secure promises and prices of importance as a daily occurrence through the telephone. But the special applications of the Telescribe will not only be as important as the uses which every large organization finds in recording wire conversations in the course of their ordinary day's work.

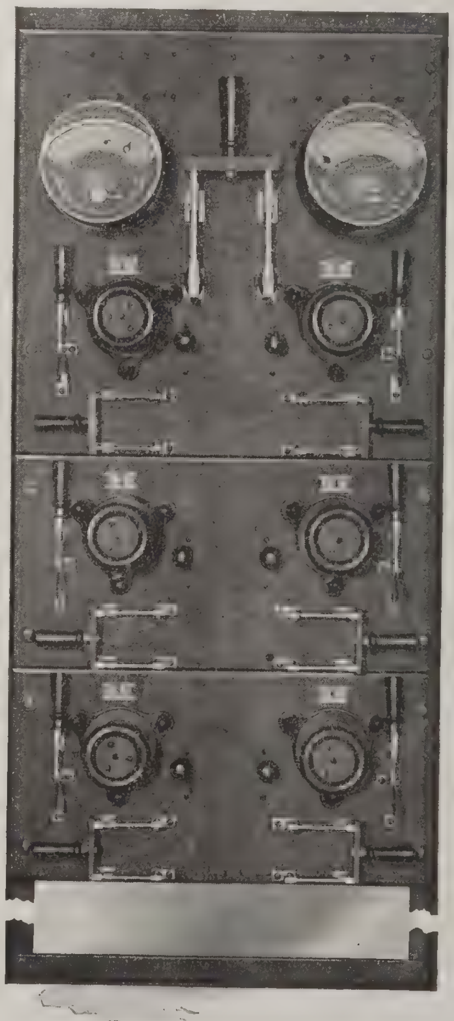
An Electric Drink Mixer.

The accompanying illustration shows an electric drink mixer manufactured by the Wisconsin Electric Company of Racine, Wis. When the device is in operation the base is illuminated and the contents of the glass lighted up, making a pretty color effect which attracts attention. The motor used is of the universal type, designed by Mr. Chas. Beach, mechanical engineer of the company. All parts are standardized and interchangeable and the outfits come to the customer knocked down to prevent breakage in transit. All parts are self-adjusting and no tools are necessary to put it together. On account of a very completely organized plant and the use of automatic machinery the company announces its ability to market this device at a lower figure than drink mixers have been sold heretofore.

The Dumore Electric Drink Mixer.

Battery Charging Switchboard for Garage Service.

A battery charging switchboard for garage purposes, simple in construction, compact and easy to operate, has been placed upon the market by the Allen-Bradley Company of Milwaukee, Wisconsin. The illustration herewith shows a battery charging panel complete with six charging stations to which four more can be added without unduly increasing the height of the board or making it awkward for the garage attendant to operate. It is built up according to the unit system which embodies the sectional bookcase idea. When complete, switchboard consists of one instrument panel and four unit rheostat panels. The instrument panel includes the main line switch, a voltmeter and an ammeter, two battery charging rheostats, the main distributing fuse panel, the wrought angle iron frame and floor supports, and the necessary switches, conductors, etc. A unit rheostat panel includes two battery charging rheostats and the necessary switches, fuses, etc., besides the proper screws for fastening the slate panel to the wrought iron frame or support of the instrument panel.

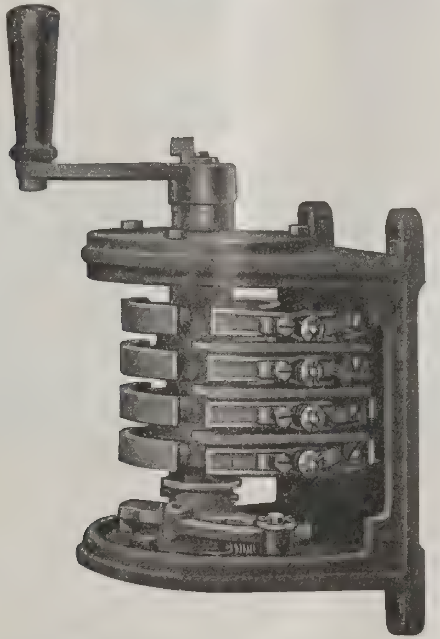


Battery Charging Switchboard.

These switchboards are built in two different standard sizes, one having 60 amperes capacity; the other 100 amperes capacity. The battery charging rheostats used are of the graphite compression resistance type, which are compact, provide good current control and eliminate all complicated wiring.

Reversing Switches for Squirrel Cage Motors.

A drum type reversing switch has recently been developed by the Cutler-Hammer Mfg. Co., of Milwaukee, designed for the reversing of small polyphase induction motors that may be thrown across the line in starting. As shown in the accompanying illustrations provision is made for operating by means of a rotary handle or by means of ropes. In the latter case the drum switch may be installed out of reach, and in a position the reverse of that shown.



CUTLER-HAMMER REVERSING SWITCH.

These switches are adapted for use on small alternating current elevator equipments driven by high resistance rotor squirrel cage motors. The enclosing case protects the switch contacts from dust and dirt, and prevents accidental contact of the live wire parts by the operator or workman.

New Steel-Frame Robbins & Myers D. C. Motors.

The illustrations herewith show a new type of direct current motor, now produced by the Robbins & Myers Company, Springfield, O. These motors have cast steel frames and are said to be especially adapted for any service where the space for installing the motors is restricted, or where light and compact construction is desirable for any reason. These motors are the bi-polar type and made in four frame sizes with outputs of ⅛, ¼, ⅓, ½, ¾, 1, 1½ and 2 horsepower, and for operation on all standard voltages.

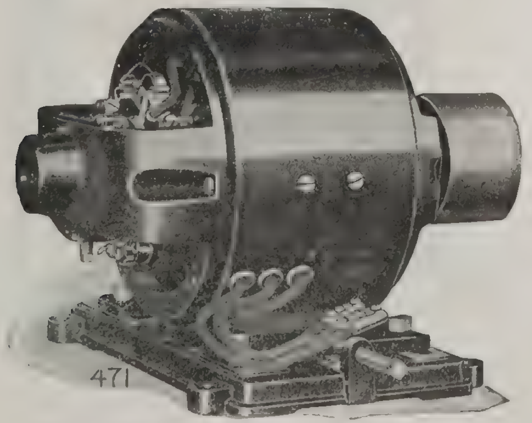


FIG. 1. THE OPEN TYPE, 1.0 HORSEPOWER STEEL FRAME.

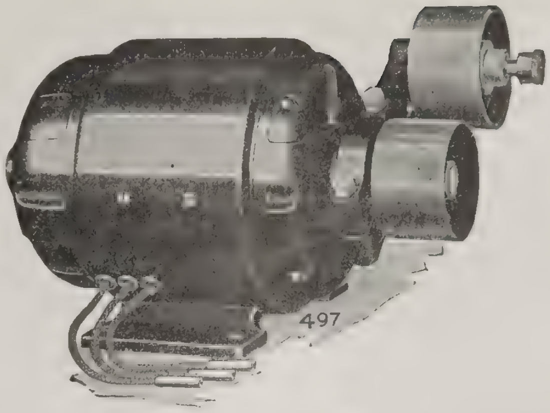
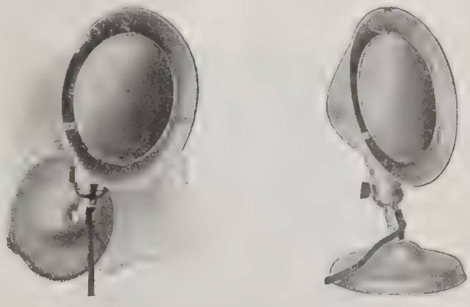


FIG. 2. AN ENCLOSED TYPE ½ HORSEPOWER STEEL FRAME MOTOR.

The line includes open, fully-enclosed, semi-enclosed and grid type frames. The motors can also be supplied with idler pulley attachments or back gears where this construction is desired and all standard outfits are equipped with sliding bases, pulleys and no-voltage release starters. The bearings are phosphor-bronze and are lubricated by oil rings. The pole pieces and armature core are built up of steel laminations. The armature coils are wound directly into the slots. The brush holders are mounted on an adjustable rocker and are the sliding box type.

A New Portable Lamp.

The accompanying illustration shows a new portable lamp consisting of a circular mirror, a metal reflector, a lamp socket, a silk cord and an attachment plug. The socket is mounted directly on the base of a hinge joint which permits the adjustment of the lamp and reflector through a wide range of angles. The mirror, six inches in diameter, is supported by three clips, flush with the opening of the reflector. The mirror is surrounded by an open space of one inch through which the light is diffused. The lamp was originally designed for the man who shaves himself. With one adjustment it illuminates all parts of the face—under the chin and both cheeks. However, after the clips have been released and the mirror removed, advantage can be taken of its adjustable features by using it on the sewing machine, the piano, and the writing desk, it also makes a very convenient reading lamp. A plug on the base provides for hanging it on the wall. The unit is manufactured by the Holophone Works of General Electric Company.



A PORTABLE LAMP.

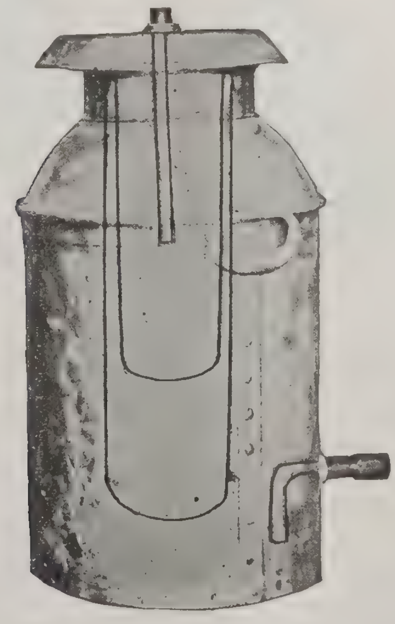
An Inexpensive Shop Vacuum Cleaner.

In every plant there are many uses for a blowing and cleaning outfit, such as cleaning dust and dirt out of generators and motors, for supplying air to furnaces, for sand blasts, blow pipes, etc., and an equipment which can be installed at little expense and used for all these purposes is most desirable. Such an equipment has been devised by Leiman Brothers, of 62 John street, New York City, the essential parts of which are shown in the accompanying illustrations. The equipment consists of a rotary pump of a design such that it can be used to create a suction in cleaning operations, and also for blowing and supplying air for the various purposes about a plant or factory. With this pump is used a simple dust separating tank and suitable lengths of hose and cleaning tools.

Pump for Vacuum Cleaner.

The separating tank can be constructed from an ordinary forty-quart milk can, which may be readily procured at the expense of a couple of dollars. The cover of this can forms an air-tight tank and makes it especially adapted for this work. A round hole is cut in the cover and a pipe connection made as shown in the sketch. The pipe or hose connecting the tank with the cleaning tool is attached at this connection. The connection from the can to the pump is made at the bottom in the same manner as above. This can is to act as a screen and toprevent the dust and dirt from entering the pump, and it therefore becomes necessary to provide a screen in the can to catch the dust and dirt. This is provided for by means of a bag made in suitable shape to set into the can about three-fourths of the way down, and made to rest over the neck of the can in such a manner that the cover will be drawn over the top, holding it secure. This bag may be made of some suitable material, such as canvas, canton flannel or suitable silk bolting cloth, depending on the amount of dust and dirt to be removed. The connection to the pump is made by means of a pipe nipple and a union. The machine is thus ready for operation after attaching a belt to the pump from a motor or a line of shafting.

There is one great advantage attached to the use of vacuum cleaning outfits which is not the case with other methods of cleaning. When a room is cleaned with this process, the dust and dirt is actually taken up and removed, and, therefore, each successive cleaning reduces the amount of dirt to be removed and makes it unnecessary to clean as often as would be the case where other means would be employed.

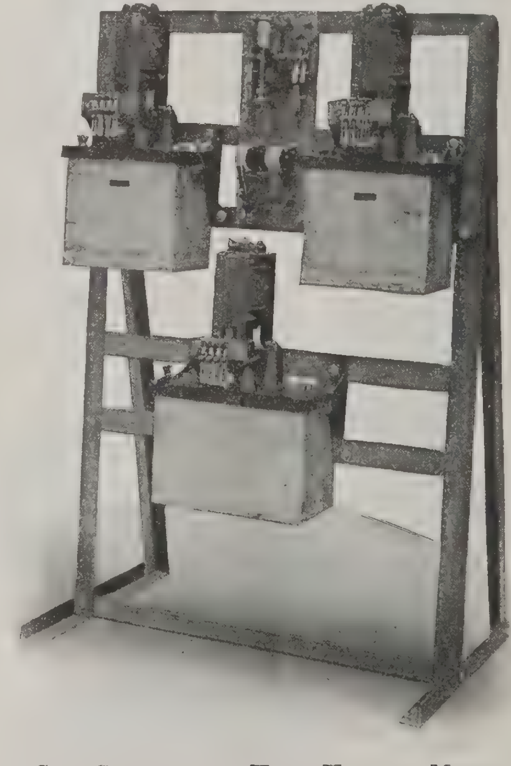


Dust Separating Tank for Vacuum Cleaner.

New Self-Starters for High Voltage A. C. Motors.

For centrifugal pumps and similar machines, squirrel cage motors connected directly to 1,100 and 2,200-volt three-phase systems are used to a considerable extent. The use of motors operating at line distributing voltages is frequently desirable for a number of reasons, and for the automatic starting of these high tension motors a new line of self-starters has been designed by the Cutler-Hammer Manufacturing Company, of Milwaukee. These controllers are of the multiple solenoid type, consisting of an angle iron, floor type, selfsupporting frame, which carries the high tension, oil-immersed solenoid switches and necessary relays controlling the motor and auto-transformer circuits.

The oil-immersed type primary and starting switches used are operated by single phase solenoids. All contacts are entirely enclosed under oil, so that no live parts carrying 1,100 or 2,200 volts are exposed. Low voltage current is used for the operation of the solenoid coils. The capacities of the standard types of these self-starters range from 20 Hp. to 300 Hp., and are made for both 25 and 60 cycle three-phase circuits. They can be automatically controlled,

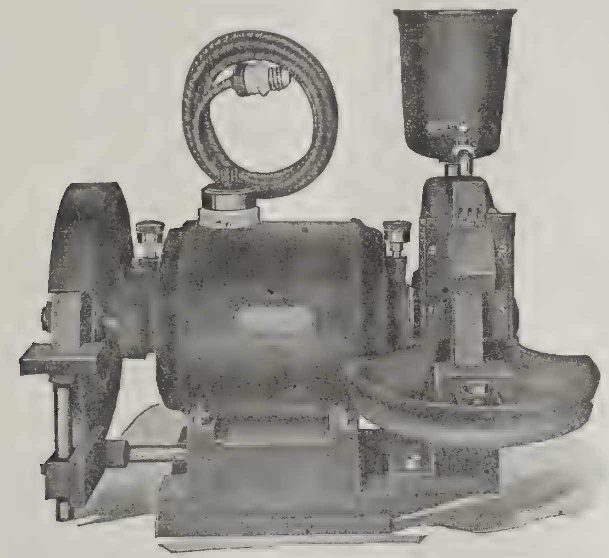


Self-Starter for High Voltage Motor.

when operating on an open tank system, by means of a float switch, and on a closed or compression tank system by means of a gage or diaphragm pressure regulator. For remote control from one or more points, control stations can be employed, so that the operator need only to push the button to start or stop the motor.

A Combination Electric Wet and Dry Grinder.

The combination wet and dry grinder illustrated herewith has recently been developed by the Cincinnati Electrical Tool Co., Cincinnati, Ohio. The motor has a capacity of 1 horsepower at 1750 revolutions per minute and is manufactured by the Robbins & Myers Company, Springfield, Ohio. It is completely enclosed to protect it from the water and dust, and is equipped with a snap switch on the frame and ten feet of cord with a plug, making the outfit portable. The outfit shown is for alternating current.



Electric Wet and Dry Grinder.

A Chemical Paint That Indicates by Color When Apparatus Is Heating.

The highest efficiency and economy in manufacture can be reached only when all professions are working harmoniously together. The mechanical engineer cannot rely upon his knowledge alone; he must consult the architect, the electrical engineer and others in order to be able to cope with the demands of a modern manufacturing plant. In this field also belongs the chemical engineer, who is pushing to the front slowly, but steadily. How much there is still in store in chemical knowledge is illustrated by a new paint which seems to have remarkable protective properties for electrical and mechanical apparatus where excessive heating is dangerous to same. This paint can be used to protect parts of machinery, bearings, etc., which are liable to run hot and cause damage, break-downs, and even fires. This paint is of a light red color, and when applied to the endangered parts will change its color according to the temperature to which it is subjected. At about 50 degrees C. it will turn to dark red; at about 70 degrees C. it will turn to brown red, and at about 85 degrees C. to nearly dark. Considering that the light red color is very conspicuous, it is obvious that any change will be readily noticed, so that it is possible to avert any damage in time. It is clear what this means for large mills where a break-down of the plant may cause a loss of thousands of dollars. The most interesting property of this paint is that it will change its color again to the original light red as soon as the part to which it is applied cools off. On this account it will serve its purpose practically indefinitely. This is important, because the ingredients of this paint are rather expensive, consisting partly of mercury iodine and copper iodine.

J. P. Schroeter.

A New Electrolytic Lightning Arrester.

For the protection of cable systems, motors and generators connected directly on a line without transformers, or transformers with weak insulation on their end turns, the Westinghouse Electric & Manufacturing Company has recently introduced a lightning arrester with a charge-and-discharge resister in series with the standard electrolytic element. This resister serves to limit the charging current to a low value and to damp out any surges that might result in charging, particularly if the system contains enough capacity to produce resonance. The arrester is made for use on circuits up to 14,500 volts.

The arrangement of the trays and the electrolyte is such that the electrolytic element acts as an electrostatic condenser. The flow of current, due to the capacity of this condenser, varies inversely as the frequency of the circuit. Thus, at normal commercial frequencies the flow of current is small, but at the high frequencies of lightning discharges and static disturbances considerable current flows through the element, increasing the action of discharging the static charges and preventing flow of current at normal frequency.

When an electrolytic arrester is being charged, surging currents are set up in the system. Under most conditions these are harmless, due to insulation of the apparatus connected in the same circuit. However, as above noted, there are cases in which these surges are dangerous, and in order to remedy this danger the graphite resister is used to damp out the surges and limit the charging current to a low and safe value. This resister is connected in series between the horn gap and the arrester in each phase. It is shunted, however, by a series of non-arcing metal spark gaps which are auxiliary to the main horn gap. In the operation of charging the, horn gap is short-circuited, as usual, and at the normal voltage of the circuit the charging current takes the resistance path rather than the shunt auxiliary gap path. On the occasion of a discharge due to lightning or static disturbances, the auxiliary spark gap path is easily broken down, and the discharge passes through same rather than through the resister, thereby assuring precisely the same freedom of discharge as in the case of an arrester which does not use the charging resister. Upon the circuit being restored to normal voltage and frequency after the discharge, the auxiliary spark gaps cannot maintain the circuit, and it is shunted to the resistance path. This action is very materially helped by the use of multiple gaps between non-arcing metal. The resister limits the amount of dynamic current flowing, and thus helps in the final action of opening the circuit by the rise and final break of the arc on the horn gap.

On each occasion of charging ungrounded neutral arresters to rebuild these films, after once bridging the horn gaps, the leads connecting the two middle legs to the ground and to the center fuse, respectively, should be interchanged and the gaps again bridged, thus serving to charge all the "legs" of the arrester. To facilitate this charge, a transfer switch is provided as shown in the illustration. A handwheel is geared to this transfer switch in such a way that the switch can be reversed without the operator in any way coming in contact with live parts, the frame of the arrester being grounded.

Electrical Construction News

This department is maintained for the benefit of contractors, dealers, manufacturers and consulting engineers.

ALABAMA.

GADSDEN. It is understood that the city is to construct an electric light plant.

GEORGIA.

ATLANTA. It is understood that the Georgia Railway & Power Company is considering the installation of a system of cables to lessen damage to water mains and fire alarm cables through electrolysis.

HELENA. The city has voted a bond issue of $13,000 to construct an electric light plant and waterworks.

VALDOSTA. It is understood that the Valdosta Lighting Company is to purchase an air compressor equipment for pumping water, or drill a deep well and install a deep-well pump. W. G. Eager is secretary.

LEESBURG. Plans are being made by J. B. McCrary Co., of Atlanta, for the installation of an electric light plant to cost approximately $30,000.

FLORIDA.

JACKSONVILLE. It is understood that the city is to install a 5000 Kw., 6600 volt, 60 cycle, turbo generator, with auxiliaries. W. A. Tucker is superintendent.

KENTUCKY.

HENDERSON. The city has underway plans for a power plant to cost $10,000. Plans are being prepared by B. L. Baldwin & Co., of Perrin Bldg., Cincinnati, Ohio.

LOUISIANA.

BUNKIE. The Bunkie Ice Company is to construct an electric light plant. W. L. Thompson is consulting engineering of Boyce, La.

SHREVEPORT. The North Louisiana Electric Railway Company is about to construct an interurban electric railway, 97 miles long, between Shreveport and Monroe.

NORTH CAROLINA.

ASHEVILLE. According to reports, final preparations are being made for the development of a water power site near the Tennessee-North Carolina line, to cost around $10,000,000. New York and Boston capitalists are financing the proposition, with the intention of transmitting power to towns in Tennessee and Alabama, including Nashville, Birmingham, Montgomery, and Mobile. Pryor Nelson, of Murphy, N. C., is promoting the proposition.

ALLENDALE. The city is to construct an electric lighting plant and bids will be open until November 18. H. S. Jaudon Engineering Co., Box 582, Savannah, Ga., are engineers.

FLORENCE. The Carolina Central Electric Co., has increased its capital stock from $500,000 to $800,000.

WHITEVILLE. It is understood that the Whiteville Commercial Club is endeavoring to create interest in an electric light plant to supply the city with light and power.

SOUTH CAROLINA.

BRANCHVILLE. The city has voted a bond issue of $10,000 to construct an electric light plant.

WESTMINSTER. The city has voted $16,000 in bonds to construct an electric light plant.

TENNESSEE.

MANCHESTER. The Hillman Hydro-Electric Power Transmission Company is to increase its capital stock to $125,000.

WEST VIRGINIA.

LOGAN. The Logan County Light & Power Co., has been incorporated with a capital stock of $1,500,000, by W. C. Lawrence, Jr., of Logan; G. W. Stephens, Jr., E. S. Alshire, and R. P. Alshire, of Huntington, W. Va., and B. C. McComas, of Barboursville. A hydro-electric plant is to be built of about 10,000 Kw. capacity, and 75 miles of 44,000 volt transmission line built. F. R. Weller, of Hibbs Bldg., Washington, D. C., is engineer.

PERSONALS.

MR. J. W. FRASER, formerly electrical engineer for Southern Power Company, who for some time has been engaged in construction of a hydroelectric plant in Tasmania, sailed on Sept. 21 for Montreal, Canada. His many Southern friends will be glad to welcome him back, we are sure.

J. J. WALDMAN, 136 Liberty Street, New York City, has purchased the Dubilier Electric Co., of New York. The latter company was a manufacturer of X-ray, high frequency, heating, wireless, medical and other apparatus.

WALTER B. SNOW, publicity engineer of Boston, Mass., has moved to Rooms 511-16 New Federal Street Building, 136 Federal Street.

W. T. KYLE has joined the sales force of The Okonite Company at their general office, 253 Broadway, New York City. Mr. Kyle for past six years has been connected with the Duplex Metals Company as district sales manager.

THE CONDENSITE COMPANY of America has moved from the original location at Glen Ridge, New Jersey, to the neighboring town of Bloomfield. The new plant covers two and a half acres of ground and includes a group of buildings especially designed for the production of Condensite. The new location is adjacent to the Bloomfield Avenue station of the Erie Railroad, and about half a mile from the Watesessing Avenue Station of the D. L. & W. Railroad. Visitors can reach it by either of these roads from New York or by trolley from Newark. The mail, telegraph and express address is Bloomfield, N. J.

THE CUTTER-HAMMER MFG. CO., of Milwaukee, Wis., announces the removal of its Cincinnati office to Room 812 Gwynne Building. The Cincinnati office was opened about a year ago and the change has been made to secure more space. Mr. Horace L. Dawson is manager of this office.

BOOK REVIEWS.

HANDBOOK ON OVERHEAD LINE CONSTRUCTION, compiled by Sub-Committee on Overhead Line Construction N. E. L. A., Thomas Sproule, chairman, and N. E. Funk, secretary. Published by National Electric Light Association, 29 West 39th St., New York City. 800 pages. Price, $4.00.

This work stands alons as a handbook on methods and materials employed in overhead line construction. In fact there is no book that treats the subject matter in as practical a way and at the same time presents in one place such a large amount of useful data and formulae. The entire book of more than 800 pages is devoted to mechanical and electrical features of line construction with a good balance between descriptive matter, illustrations, and practical tables, curves, etc. The book is divided into the following sections: 1. Dictionary of Electrical Terms, useful tables; 2, Distribution and Transmission Line Supports; 3, Conductors and Wire Tables; 4, Cross-Arms, Pins and Pole Line Hardware; 5, Insulators; 6, Transformers and Induction Regulators, protective apparatus, grounding, etc.; 7, Electrical Calculations; 8, Mechanical Calculators; 9, Preservative Treatment, poles and cross-arms; 10, Primary and Secondary Line Construction; 11, General Data.

This handbook will be found a constant help to all linemen and its price reasonable indeed, a mighty good investment.

EXPERIMENTS. By Philip E. Edelman. Published by the author, Minneapolis, Minn. 250 pages. Price, $1.50.

This book takes up selected experiments covering a wide range of subjects together with instructions for making devices of known worth. The experiments have to do with chemistry, electric motors, electrical devices of all kinds, telephones, wireless, X-rays, etc. To all interested in experimenting and investigating electrical fields, this book will make a strong appeal.

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Electrical Engineering, Atlanta, Ga.

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The Safety First Movement.

No movement has been taken up so generally and enthusiastically in this country by public utilities, industrial corporations and railroads, as the so-called "safety first" movement. This activity besides having a humanitarian viewpoint has a decided economic aspect for it is doing more than reducing avoidable accidents, it is increasing the efficiency of employees by tending to eliminate carelessness and indifference and encouraging observation on the part of workmen in the performance of regular and routine duties. From the standpoint of the company it is reducing accident liability and increasing production through fewer interruptions and the breaking in of new men, so that accident prevention now suggests a saving of misery, saving of money and a protection to both employee and employer.

As an indication of the benefit from a humanitarian standpoint, the data contained in a report of the United States Commissioner of Labor for a single industry, the iron and steel industry, is significant. This report shows that where organized accident prevention is in force that the accident rate is as low as 167 per thousand workers per year while in plants where organized accident prevention is not in force the rate is 507 per thousand and higher. In this industry then, the movement has been responsible for a 67 per cent reduction in accidents. The Carnegie Steel Company has been able to reduce its accidents about 71 per cent. The Northern Pacific Railroad shows a reduction in deaths due to operating accidents on its system for the first six months of 1914 as compared with the same period of 1913, of 73 per cent and reports from other industrial companies, according to good authorities, show that reductions are possible of at least 20 per cent and as high as 80 per cent depending upon the nature of operating conditions involved. Certainly this protection and preservation of human life is a worthy work for the captains of industry.

In this work of preventing accidents, it must be remembered, however, that no individual or company can by the use of any device or system entirely eliminate accidents due to the part played by such factors as carelessness, ignorance, indifference, negligence and oversight on the part of human beings. This is especially true in the electrical industries where the safety movement involves the use of rules, instructions and warnings concerning dangers to life and limb. This was clearly shown in a recent report on accidents in the New York Edison Company in which it was stated that 85 per cent of accidents were due to carelessness and negligence of employees, 6 per cent due to carelessness of fellow servants, 2 per cent due to outside contractors and 7 per cent chargeable to the company. A report from a large manufacturing company involving some 20,000 workers shows that, contrary to the original idea that lack of safeguards to machines was largely responsible for accidents, less than one-half of one per cent of all accidents is due to this cause. This does not in any way belittle this feature of safety work but goes to show that the prevention of accidents is a most complicated work with its success depending largely upon a knowledge and study of all hazards and the tendency of the average individual to take a chance.

The secret of the greatest possible results in preventing untimely deaths and injuries in all industries seems to lie in the proper combination of mechanical precautions and educational work coupled with a careful analysis of causes contributory to accidents, such as fatigue, carelessness, intemperance, worry, desease, etc. One writer on this subject has the following to say in regard to preventing accidents and a method of disciplining employees who fail to observe set rules and precautions in electrical work: "The man who is installing a switch on a switchboard is probably alert enough to keep his hands off the dangerously exposed wire but his helper who has not much to do, except hand him his tools and blow torch, and gets tired of standing about, is very likely leaning against the switchboard and his hand may unconsciously come in contact with a dangerous exposure, simply because he is thinking of something else. Thus it becomes necessary not only to make our work "fool proof," but, as Mr. Edison says, "damn fool proof." An important point which has to be considered in this endeavor to make safety the dominating note, is disciplining an employe. The company lays down certain very rigid rules, and the greater part of our accidents are known to be directly attributable to some one disobeying or disregarding these rules. In doing this a man not only risks his own life and that of his fellow employe, but is liable to cause enormous damage to the company's property. There is too little notice taken of infraction of these rules; merely reprimanding a man and warning him not to do a thing again does not always bear fruit. A man is unfortunately more apt to risk his life than his job, and it is for this reason the company is endeavoring, first to educate its men up to the 'safety-first' idea, and, secondly, enforce obedience to rules. We do not, as a rule, kill our new men, it is usually the old men, who have played the game a long while who are hurt, and the only cure for this condition is the unbiased, rigid disciplining of the men who disobey rules. In one company, the man who is found working on a pole without his safety belt and gloves is immediately discharged and in addition to this, the foreman under whom he is working is also at once dismissed for allowing the man to disobey the company's rules. This ruling may seem very drastic, but the practical results obtained from its enforcement, in the lessened number of accidents is very marked."

In connection with the safety work being done by public utilities and industrial corporations, it is important that a mention be made of the assistance given by the United States Bureau of Standards through an investigation and study of life hazard in the generation and distribution of electrical energy. The bureau has published a set of safety rules covering the operation and handling of electrical lines and equipment and all these rules find application in the larger industrial and private plants and to utilities of moderate size and to a more or less extent to smaller organizations. Organized accident work is also touched upon and abstracts made from the excellent report on this subject made by the 1913-14 accident prevention committee of the National Electric Light Association as well as from methods used by several large and small utilities.

While the safety first movement is now well launched, it is in need of careful direction, support and study by both employees and employers that no time be lost on unimportant details while the destructive forces involved carry on their havoc of misery and death. We believe the suggestion of discipline mentioned above an excellent one and that first and foremost every employer should make sure that his safety rules shall be iron clad with the penalty for failure of observance, if not a discharge, an amount of money to be taken from the employee's salary and set aside for relief work among injured employees.

Byllesby New Business Activities Not Diminished Because of War.

Aggressive efforts to develop additional electric and gas business along existing lines and mains have not diminished during the war at the utility properties managed by H. M. Byllesby & Company. Weekly reports show steady and substantial increases in connected load. At Louisville, Ky., campaigns for the equipment of dwellings to burn natural gas for house heating and to induce the electrical wiring of already built houses are being successfully prosecuted. An advertising campaign to promote house and store wiring at Minneapolis in July, August and September more than doubled the ordinary gain in this class of development. Fall house-wiring campaigns are in progress at Ottumwa, Iowa, and other cities. Nowhere has newspaper advertising been curtailed, and special effort has been made to call special attention to the fact that there is no necessity to economize in electricity and gas, since the prices of these commodities remain low, in war or peace, without impairment of quality. The combined earnings of thest properties for the ten months ending October 31, showed an increase of 7 per cent in net earnings over the same period of 1913, indicating that war conditions are not depriving public utilities of the opportunity to make reasonable gains.

Executive Committee of Southeastern Section of the N. E. L. A. Selects Asheville, N. C., for Next Convention.

The first meeting of the 1914-15 executive committee of the Southeastern section of the National Electric Light Association was held at the Hotel Ansley in Atlanta, Ga., November 19. Besides the members of the committee which is made up of one central station representative from each of the following states, Georgia, Alabama, Florida, North and South Carolina, several others interested in the work of the section were in attendance. Among these were Mr. William Rawson Collier and Thomas W. Peters, past presidents of the section and Robert N. Lee of the Society for Electrical Development of New York.

The committee voted to hold the next convention of the section September 22 to 24, 1915, at Asheville, N. C., with headquarters at the Grove Park Inn. The various working committees for the year were selected and special arrangements discussed for attending the convention, Mr. William Rawson Collier being appointed to take this matter in charge. Mr. H. W. Plumber of the Asheville Power and Light Company was appointed chairman of the committee on local arrangements and entertainment.

Rebuilding of Hot Springs, Ark., Light And Railway Property

BY S. F. ALLEN, OF GAUTHIER, ALLEN & JONES, ENGINEERS, MINNEAPOLIS, MINN., FORMERLY ELECTRICAL ENGINEER OF FEDERAL LIGHT AND TRACTION CO.

Section 2. Details of New Station at Hot Springs (Ark.) Constructed in Record Time.

While work was progressing in reestablishing the lighting and railway service in Hot Springs, and before the temporary station started operation on Sept. 25, 1913, plans were being prepared in the field for the building of a modern fire proof steam generating station outside of the city limits and situated between the main line of the Iron Mountain railroad and the Hot Springs Creek. The site chosen for the location of the new station was one of the best available in Hot Springs on account of its close proximity to the creek, the water of which, at certain times of the year, can be used for condensing purposes, besides being away from the center of the city, thus reducing the risk should another big fire ever sweep the valley in which the city is built, as did the conflagration of September 25th, 1913.

The new station is of particular interest due to the fact that it is a reinforced concrete structure, with the exception of the roof which is of steel. This was adopted with a view in mind of not having the building work held up for the structural steel deliveries. After sketches were prepared and adopted, rush orders were placed with the Kahn Concrete Steel Products Co., for the necessary reinforcing bars and other reinforced concrete materials to carry the floor and column loads, shipment of which was made so that the building was rushed through. This material was on hand before the form work for the building columns was completed, thus the construction work was not delayed or postponed as would have been the case in waiting for structural steel for the roof and crane supports.

PROGRESS OF WORK

Excavation work for the new plant was started on September 16th, 1913. By December 14th, the plant was ready for emergency operation with 2-316 horsepower boilers under 175 pounds pressure and a 1000 Kw. condensing turbine available and ready to cut over to the new distribution system, which had been built in the meantime, and connected the new plant with the center of the old distribution, in case something had gone wrong with the temporary plant, put in operation after the fire as already described. On January 1st, 1914, or three and one-half months after work was started, the new generating station was put in regular operation which permitted releasing some of the equipment of the temporary station, and this was dismantled and reerected at the new plant. The new generating station has been in continuous operation since January 1st, 1914, as stated above, and is now effecting a saving of $15,000.00 per year in power production costs compared with the production costs of the old station.

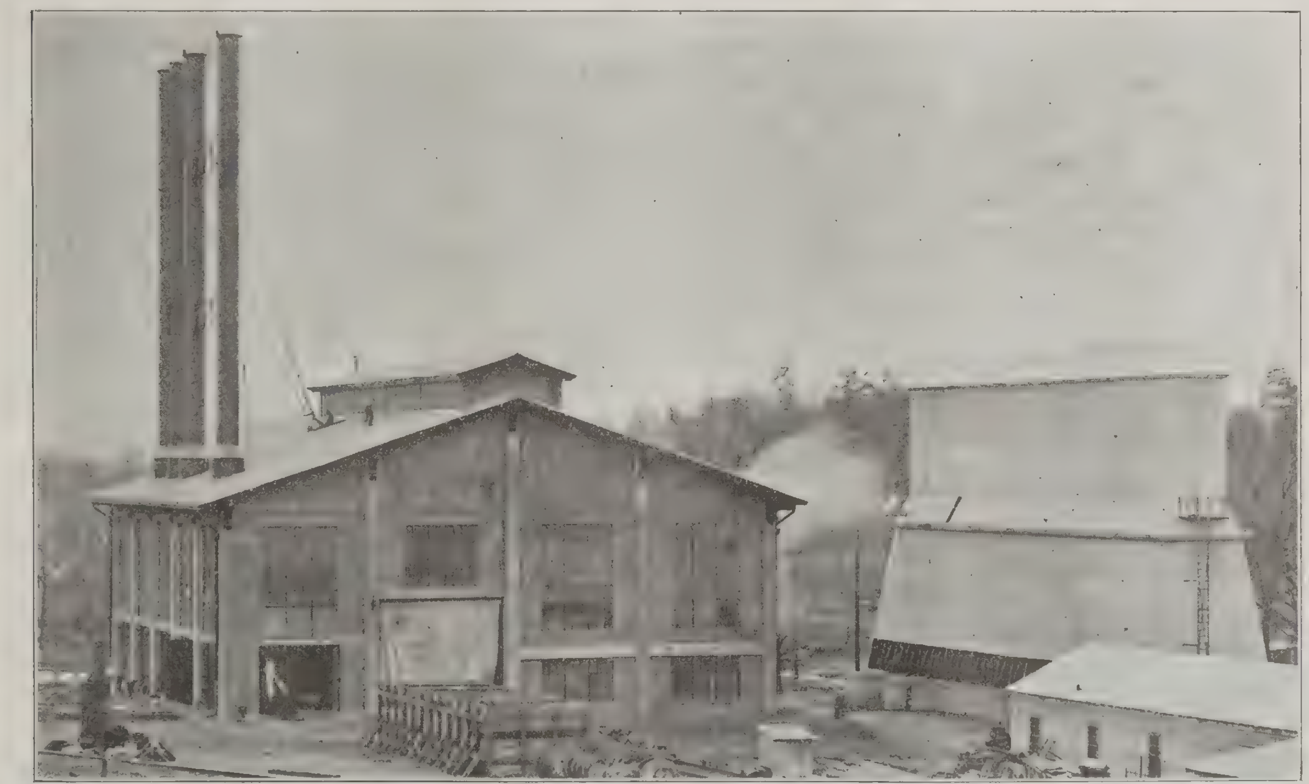


Fig. 1. Showing Hot Springs Station and Cooling Tower.

STATION BUILDING.

As stated previously, the new generating station is constructed of reinforced concrete, brick and steel and is fire-proof throughout, as not a piece of wood or inflammable material is used in the inside or outside trimmings. The power house consists of three parts, the generating room in which is located the turbines, exciter sets, motor generators and switchboard apparatus, the basement under the engine room for the condenser equipments and auxiliaries and the boiler room in which boilers, feed pumps and feed water heaters are located. The building is approximately 87 feet long, divided into five panels, 17 feet center to center of building columns; 84 feet wide and 35 feet high, with provisions made in the engine room for a future generating unit. The boiler room can accommodate two additional boilers without any extension. A 15 foot basement under the engine room accommodate the condenser equipments, toilet and wash rooms, also a complete motor driven machine shop.

BOILER ROOM

The boiler room is equipped with four 316 horsepower Heine water tube boilers equipped with furnaces that can use gas or coal as fuel. These boilers are installed in a row parallel to the engine room wall and approximately 19 feet from the wall to permit tube renewals. Each boiler is equipped with a steel stack 110 feet high. The draft is regulated by a mechanically operated damper mechanism extending to the front of each boiler and easily accessible to the fireman. For ventilation or cleaning purposes the wall opposite the rear of the boilers is provided with large openings closed by means of large sheet iron doors. There is plenty of firing aisle and operating space in front of the boilers, and at each end of the boiler room directly opposite the wide firing aisle, the space between the boilers and the walls is provided with large steel doors and windows resting on structural steel frames and supports so designed that the whole section of doors or windows can be easily removed and permit future equipment to be brought in the building.

Natural gas, piped from the oil fields of Caddo Parish in Louisiana, is the only gas supply used in Hot Springs, which supply is controlled by the Consumers Gas Company a subsidiary company of the Federal Light and Traction Company. This gas is used as fuel at the new plant, although provision is made for coal should the gas supply fail or drop in pressure. Each boiler is equipped with eleven gas burners manufactured by the Gwynn Engineering Company of Pittsburg, Pa. These gas burners are connected to the gas header through a six-inch manifold made of extra heavy pipe which is tapped to receive the gas burner connections. The supply to these burners is regulated by means of 1½ inch valves located close to the burners. Gas meters and regulators are provided with by-pass connections in a separate compartment under the boiler room floor.

For emergency coal burning, each boiler is also equipped with Jones underfeed stokers. Blowers for forced draft in connection with the underfeed stoker installation are installed outside of the boiler room and supply the necessary draft to each boiler through a concrete air duct installed under the boiler settings and connected to each furnace with galvanized ducts equipped with a butterfly type of valve for regulating the air supply to the furnaces.

The distance from the operating floor of the boiler room to the lower chord of the roof trusses is 29 feet. This affords ample head room for the future installation of coal bunkers and coal handling equipment should the gas supply fail or be discontinued for the use of coal only. For the same reason, during the construction of the plant, the space between the boiler fronts and fire wall was excavated and finished so as to have an available space ready for a future ash pit. Boiler foundations were built, so that by the removal of a four inch slab of concrete under the furnace, ash hoppers can be easily installed so as to dump the ashes into an ash car. For the present, ash traps are

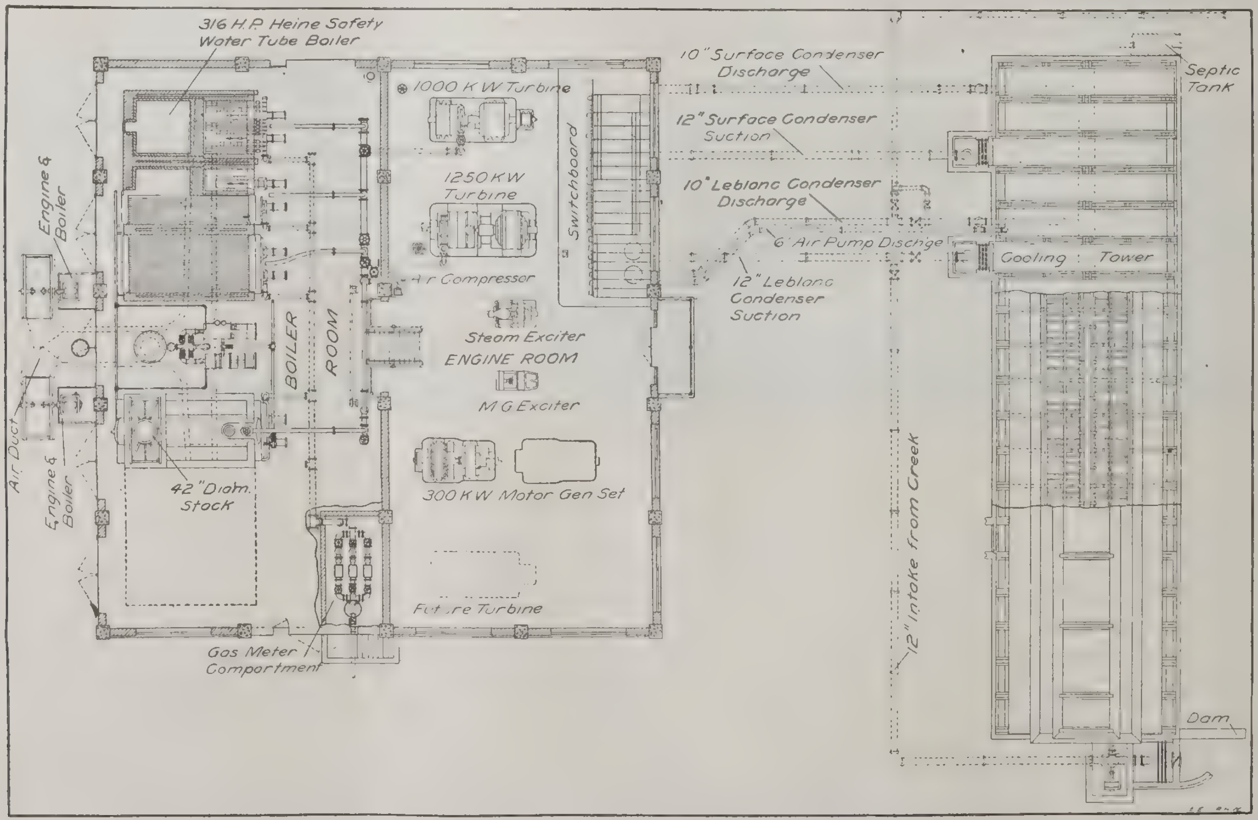


Fig. 2. Plan of Power Station Showing Arrangement of Apparatus

left in the floor in front of each boiler so if coal should be used in emergency, the ashes can be raked into the pit for removal.

A steam pressure of 175 pounds is carried on the boilers. The boilers feed steam through bents and lines extending down into the steam header which is located parallel with and close to the fire wall, three feet above the operating boiler room floor. To provide for expansion the header is broken into an 8 inch pipe and arched above an opening in the fire wall which opening is left as passage way between the boiler and engine rooms. Steam connections to the turbines pass directly through the boiler room fire wall. Auxiliary steam connections are taken from the main steam header to supply steam to the condenser auxiliaries and steam exciter. Steam for the operation of feed pumps, fan engines, soot blowers, etc., is taken from a special tee provided for, below the safety pop valves.

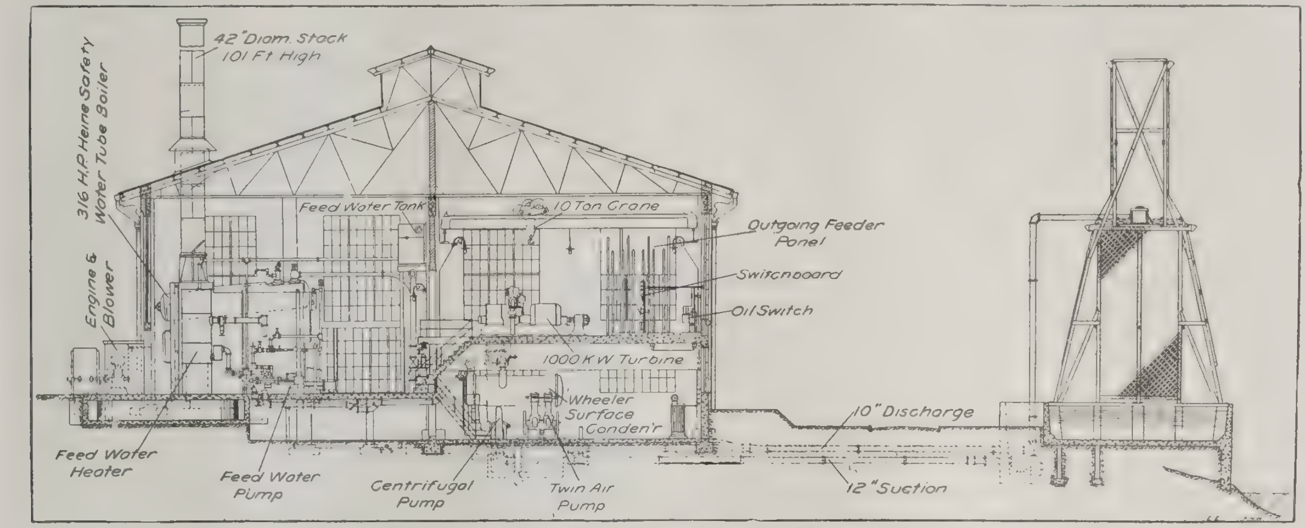


FIG. 3. SECTION THROUGH STATION SHOWING LOCATION OF APPARATUS ON DIFFERENT ELEVATIONS.

Boiler feed water is supplied from a 4 inch water line entering the boiler room from two points and is also obtainable from connections taken from the condenser discharge lines, the condensed water and also the drainage from all steam traps. The feed water enters an elevated tank from which it flows, by gravity, through an open feed water heater, from which the boiler feed pumps force it in the boilers. The feed pumps are located in the center panel of the boiler room, where their operation is at all times under the observation of the engineer on watch. The piping and valves, to and from the feed pumps, are arranged in duplicate and so that every valve is easily accessible and convenient for operation. By opening or closing the proper valves each line may be fed by separate feed pumps which makes it possible to supply hot or cold water to separate boilers. If desired, the piping is such that the feed water may be by-passed and the water pumped directly from the supply into the boilers.

GENERATING EQUIPMENT

The engine room equipment consists of one 1000 Kw. and one 1250 Kw. 2300 volt, 3-phase, 60-cycle, turbo-generators of the General Electric Company. Provision has been made for the installation of an additional unit. At present one of the units is held in reserve, but with the increase of the load anticipated by the rapid rebuilding of the burned district, it will soon require the spare unit to be placed in regular operation. Two 300 Kw. General Electric motor generator sets for railway service are also installed and connected and are part of the generating equipment. One 30 Kw. motor generator exciter set and one 35 Kw. steam driven exciter. The 1250 Kw. turbo-generator mentioned above is the unit which was damaged by the fire and was rewound, repaired and reinstalled at the new plant soon after the new 1000 Kw. turbine was in regular operation and carrying the load.

All wiring in the power house was run in iron conduit with the ends of all runs terminating with suitable condulets. Before the wires or cables were pulled into the conduit, all runs were thoroughly cleaned by pulling swabs

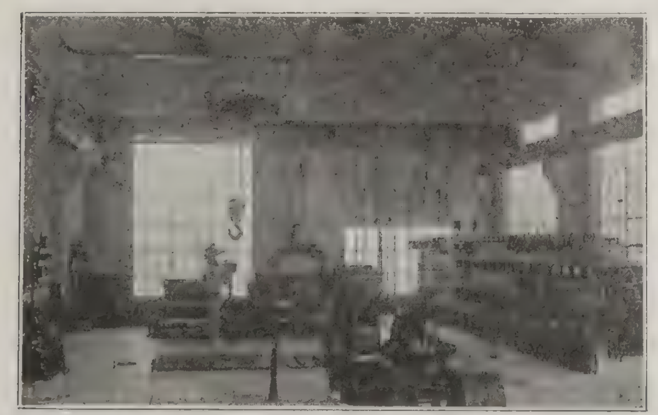


FIG. 4. TURBINE ROOM OF STATION SHOWING EXCITERS, SWITCHBOARD AND ONE TURBINE INSTALLED.

FIG. 5. BOILER ROOM SHOWING GAS BURNING ARRANGEMENT.

through same and then applying warm air to dry any moisture they may have contained. After the cables had been pulled in the conduits for the 2300 volt leads, the following method was used to seal the ends of each run. For condulets terminating in a horizontal position "oakum" was packed around the cables where they entered the condulet from the conduit, to prevent the hot compound from running back into the conduit, the cover was then placed in position and "oakum" packed around cables where they pass through the cover. Previous to pouring the compound, two holes were bored in the condulet, one for a vent and one used to pour compound into the condulet. With the vertical condulets it was only necessary to pack the "oakum" around the cables where they entered the condulet and pour the compound and then place the cover. The sealing of these conduit runs prevented condensation in same which is found at times to cause considerable trouble. All of the 2300 volt cables were arranged so that all runs were continuous from end to end thus eliminating any splices in the conduit or condulets. The cable used was cambric covered tested for 3500 volts working pressure.

A color code was established at the main bus bars as red, white and blue and carried out with colored wire and cables, including switchboard, instrument and entire wiring system, with the exception of the station wiring and arc conduits. The same code extends to the outside distribution system of the City, the labeling of the wires was taken care of by marking the cross arms directly under the wires the letters R. W. and B. at intervals along the pole lines. All 2300 volt wires of the distribution system were known by their respective letters and their relation to the main bus-bars at the power house, is expected to be of great value in case of trouble and in keeping the distribution system balanced.

The instrument wiring running from the current and potential transformers to the switchboard was run in the same pipe that supported the switchboard, oil switches, bus-bars, etc. Holes were drilled and tapped in the pipes of this frame work, and hard rubber bushings inserted, for the wires to pass through.

All the three-phase feeders were arranged for automatic induction type feeder regulators. The current transformer for the compensation winding of the Tirrill regulator is connected to the main bus-bars back of the leads that feed the motors on the motor generators so that the load variation on the station, caused by the railway operation has no effect on the compensation. The lighting and power load only affects the compensation winding of the Tirrill regulator. All outgoing feeders to the distribution system run from the oil switches in iron conduit to a concrete panel built in the wall of the building. The conduit passes through this concrete and is terminated with a condulet on the outside of the building. Angle-iron cross arms mounted on brackets secured to the concrete panel with through-bolts formed the dead end for the feeders extending to the junction tower.

It has been found from previous experience that iron conduit, used for outgoing leads, acts as a good choke coil. Therefore, the lightning arresters, being of the electrolyte type, were located outside of the power house in a special housing mounted below the cross arms of the four pole junction tower.

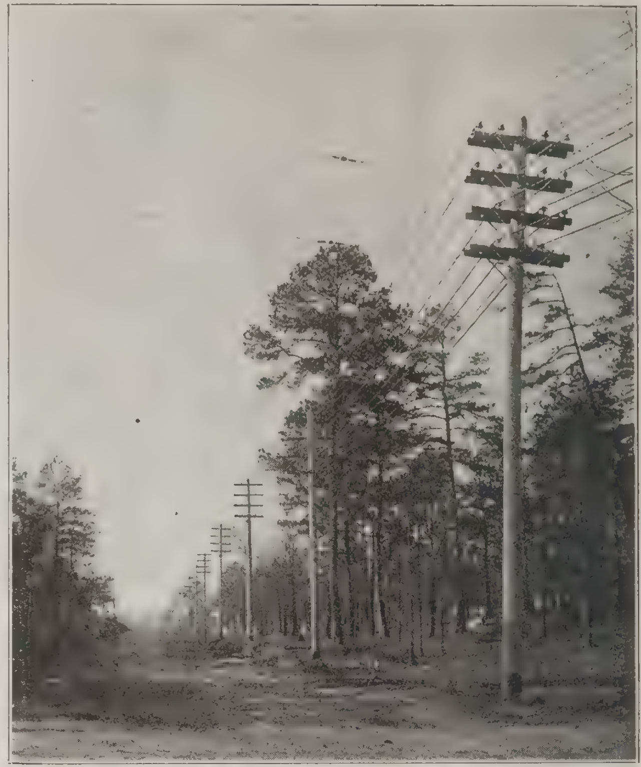


Fig. 6. Type of Distribution Line From Station Carrying 2—3-Phase, 2300 Volt Feeders; 2—Arc Lighting Feeders and 5 Railway Circuits.

Before the new station was put in service, all current carrying apparatus was tested by short circuiting just back of the part to be tested and an overload current applied by slowly building up the generator to the desired current. After the current had been applied the desired length of time, all the clamped joints, terminals, etc., were gone over to ascertain if any undue heating had been caused during the short circuiting test. The outgoing A. C. feeders were tested likewise. The short was made outside of the building, and the same method of applying the overload current, was used on each feeder individually. These tests were not only advantageous in checking for carrying capacity, but were to great advantage in checking the ammeters and calibrating the overload trip coils. All of these tests were made after the drying out of the turbo-generator was completed.

CONDENSING EQUIPMENT AND COOLING TOWER

Each turbo-generator is provided with a condenser unit as follows: The 1000 Kw. turbine is provided with a Wheeler surface condenser new, having a steam driven circulating pump and an Edwards twin air pump. The 1250 Kw. turbine is provided with the No. 13 LeBlanc condenser which went through the fire without any serious damage and was reinstalled at the new plant. Condensing water is furnished from a cooling tower located within fifty feet of the power house building and along the bank of the Hot Springs Creek. It will be noted from the cross section of the power house that the condenser pumps are located, so that no lift or priming is required to put the circulating pumps in operation. Each condensing equipment has its individual injection and discharge pipe lines to and from the cooling tower.

The cooling tower is of the chimney draft type adopted by the Federal Light and Traction Company and has proven very efficient at several of their other properties. The tower is 100 feet long, 30 feet wide and 26 high. A 20-foot chimney 10 feet wide is built over the whole structure and gives sufficient draft at all times so that no fans of any kind are required to lower the temperature of the discharge water. A system of square wood slats laid on edge and located in a staggered position permit sufficient air to circulate through the tower and also provide sufficient cooling surface so that the temperature of the discharge water is within a few degrees of that of the atmosphere temperature by the time it reaches the concrete basin built under the cooling tower to retain the water until it is pumped through the condensers. A special suction line was connected with the Hot Springs Creek so as to furnish an additional supply of water when operating the LeBlanc condenser.

The arrangement of the power station apparatus was adopted with a view of having the plant as compact as possible also for the most efficient and economical operation with a maximum crew of three men per shift. This was one of the reasons for facing the boilers toward the engine room and so that the operating engineer, in charge of the station, could easily watch the boiler room operation from a platform on a level with the engine room floor and which extended 24 inches into the boiler room and through a wide opening left in the fire wall in the center of the building.

The electrical equipment was furnished by the General Electric Company. This includes turbines and switchboard. The boilers were furnished by the Heine Safety Boiler Company. The Kahn Steel Products Company furnished all the re-inforcing steel for concrete purposes as well as the steel sash and doors used throughout the building. The local erection work of the turbines, switchboard, boilers, stacks and piping was done by the regular construction force of the Federal Light and Traction Company.

The whole of the work described was done by the Federal Light & Traction Company's Engineers under the personal supervision of W. A. Haller, general superintendent and chief engineer, assisted by Geo. J. Gauthier, designing and construction engineer.

Practical Discussion Of Induction Motor Characteristics

BY H. G. DAVIS, E. E.

Section 2. The Torque of an Induction Motor and Changes in Speed.

THE torque of a motor is the turning or twisting effort exerted and is expressed in pounds at one foot radius. Since horsepower is the rate of doing work expressed in foot-pounds, it follows that the horsepower of a motor is equal to its torque multiplied by the speed of a point on the rim of the pulley in feet per minute. It can thus be seen that for a given horsepower rating of the motor, the torque will be reduced as the speed of the pulley is increased. That is for a given number of revolutions per minute, a large pulley will exert less pull on the belt than a smaller pulley to give the same horsepower. However, with an increase in peripherial speed of the pulley, a greater horsepower is transmitted to the belt. This is shown from the following formula:

$$\text{Torque} \times (\pi d \times \text{rpm}) = \text{H. P.} \times 33{,}000.$$

Considering $d = 2r$ and $r = 1.0$ foot radius of pulley, then,

$$\text{Torque} = (\text{Hp.} \times 33{,}000) \div (2\,\pi \times \text{rpm.}) = (5260 \times \text{Hp.}) \div \text{rpm.}$$

This formula gives the pounds pull at one foot radius and, if the pulley diameter or radius is known, the pounds pull on the belt for the pulley can be determined by dividing the torque expressed in foot-pounds by the radius of the pulley in feet.

For an induction motor if the revolutions per minute as used in the above equation is taken as the synchronous speed, (which speed can never be reached for the reason that to have a torque, the motor must have a slip below synchronism) the torque is what is called synchronous torque to produce the required horsepower. When the revolutions per minute is the actual known speed when delivering the horsepower used in the equation, the torque is the actual resulting torque. This applies to all motors or any shaft transmitting power.

Torque produced in an induction motor is the product of the effective current polarization of the secondary by the effective flux by the sine of the angle between the two. The effective flux for a given motor using a given frequency will vary with voltage. The sine of the angle between flux and current polarization varies as a function of the slip and motor constants, resistance and reactance. The result is that for a given motor frequency and slip. Then,

Torque = constant × voltage squared.

This means that the torque varies as the square of the applied voltage for a given speed and frequency. Thus since power is torque times speed, the power output of any motor at any speed will vary as the square of the voltage impressed at the terminals.

From a mathematical consideration of torque equations it can be shown that the rotor resistance determines the starting torque. For high torque at starting the rotor resistance must be high. If a squirrel cage rotor is desired to give high starting torque, we have a high resistance loss in the rotor which means lowered efficiency with decreased maximum output and increased slip for maximum torque and maximum output. Hence the advisability of using a wound rotor type of motor when high starting torque is desired. The extra resistance necessary for high starting torque can then be cut out after the motor has started and in this way high starting torque and high efficiency are opposed in a way.

In determining the extra resistance for the rotor of a motor to give a required starting torque, we find that two values will satisfy the condition. The large value will give small starting current with torque falling off rapidly as the machine speeds up. The smaller, value will give large starting current but the torque will increase rapidly as the machine speeds up and approaches synchronism.

SOME WINDING CONSIDERATIONS AND TWO SPEED CONNECTIONS.

An induction motor is often desired to work at two different speeds. The motor can be so connected but the output at the lower speed is greatly reduced. Consider a three-phase motor to be used at full speed and at half speed. Connections can be brought out so that, by a change-over switch, the change in speed can be made. The connections to be used are as follows, with the normal horsepower rating that can be used at the two speeds and the maximum horsepower output of the motors as given. In each case the rating at full speed is considered as unity.

Motor speed	Connections and No. of circuits	Rated Hp.	Max. Output
Case I.			
Full	Star—2-circuits	1.0	1.0
Half	Delta—1-circuit	0.5	0.5
Case II			
Full	Star—2-circuits	1.0	1.0
Half	Star—1-circuit	0.25	0.166

The connections in Case I. should be used when the output required at half speed is one-half the output required at full speed. Even in this case the motor will be larger than a single speed motor due to the increase in tooth density at half speed calling for a larger motor. The connections in Case II should be used when the output at the reduced speed is very low compared with the output required at full speed.

However, the size of the motor can be such that the output at full speed is as large as possible for the size of the motor. This is due to the fact that the tooth density at half speed is lower than at full speed for this connection.

The change in speed for an induction motor means of necessity a change in the number of poles in the arrangement of the winding. This of course changes the reactance and flux density of the motor with the resultant change in output as given above for the full and half speed connections. In any case re-connecting for a change in speed involves a change in the constants of the motor with a resultant change in the motor output. When this is thoroughly understood, the frequent desire on the part of induction motor users to change the speed of the motors on the job and obtain the same output at a reduced speed, would be easier to meet with the explanation that it is not always feasible and never desirable without information from the factory as to the constants and connections of the motor in question.

A quarter phase motor of a given voltage can be changed to a 3-phase star connected motor for the same voltage if reconnected with the same number of circuits per phase. In this case there will be a reduction to 82 per cent in flux density with a reduction in output to above 68 per cent since the output will vary as the square of the density.

A 2-phase, 220 volt motor having 2 circuits per phase can be changed to a 3-phase star connected motor for 550 volts to give the same output. With this connection the flux density is increased 4 per cent and the maximum output about 16 per cent. This same output and flux density can be obtained from the reconnected motor at 528 volts. In each of these cases, as given, the change from two phase to three phase is assumed to be made by holding same frequency and speed. In each case the copper current density is less for the three phase motor at the same output than for the two phase connection. For the same density in the copper and iron we get a 5 per cent increased output after changing to 3-phase.

In figuring the capacity required in an induction motor for a given service, the duty cycle should be determined. Where the load is steady for long periods with an overload of a known quantity for a short time, the capacity of the motor is very easily determined. However, it is where the loads are sudden and the torque values are high for short periods that the cycle is hard to determine. For this type of service which is found in rolling mills and sugar refineries, the duty cycle should be determined, giving the instantaneous horsepower required over the period forming a complete cycle. That is, the service of the motor will be starting, then a fluctuating load with a maximum horsepower instantaneous demand perhaps for a few minutes, then a decreasing load to zero and perhaps a period of no load or standstill. The time from the starting of one cycle to the starting of the second cycle will form a complete period. If the rest period of the motor or running idle position of the cycle is long compared with the running period, then the cooling effect during this time will offset a permisable overload during the loaded portion of the cycle provided the torque required is not greater than the torque that the motor will give during the overload cycle.

If we plot the horsepower instatanenous demand as ordinates and time as abscissae, we have the necessary information for determining the motor rating. The ordinates for short periods should be squared. Take the sum of these squares and divide by the time. Take the square root of this result and obtain the horsepower rating. Thus for a ten minute cycle we could take the average ordinate for one minute periods, square these ordinates, take the sum of the ten which have been squared, divide by ten and take the square root of the result for the horsepower rating. The heating varies as the square of the horsepower, and this determines the rating of the motor.

Starting motors have a special duty cycle requiring high torque. Thus for this short period the heating is not the characteristic that determines the rating but torque demand. In designing motors for starting, motor generator synchronous sets and rotary converters, the torque necessary is a variable quantity and the information and data on this subject is limited. The torque necessary will depend on the condition of the bearings and the length of time the machine to be started has been at rest. If oil pressure can be obtained in the bearings the set can be started with a lower torque. For starting a rotary converter where a starting motor is used, the motor horsepower is usually taken as about ten per cent of the rotary rating in kilowatts. For starting large motor generator sets the motor horsepower is taken about 15 per cent of the kilowatt rating of the set. The torque necessary to start a set will vary from 10 per cent to 30 per cent of full load torque of the set. The motor is usually supposed to bring the set to full speed in one minute and thus the revolving parts of the set must be accelerated to full speed in one minute. This determines the amount of energy to be delivered by the motor in that period and this energy must be determined from the weights of the moving parts of the set and the radius of gyration of the revolving parts.

For example we will assume a 200 Kw. motor generator set having a normal speed of 900 revolutions per minute. Suppose this set has to be started from rest and brought up to speed in one minute. In order to synchronize the set, assuming it is a synchronous set, it must be run above speed by the motor and synchronized as the speed drops off after the starting motor has been cut from the circuit. If the set has a 60 cycle motor and operates at 900 revolutions per minute, the nearest synchronous speed for a 60 cycle starting motor is 1200 revolutions per minute so that the starting motor must have 6 poles and a synchronous speed of 1200 revolutions per minute on a 60 cycle circuit.

Assume a set rating 200 Kw. and a starting torque of 25 per cent of full load torque. Then the torque required of the starting motor corresponds to 50 Kw. running torque and 50 Kw. torque divided by 0.746 equals a 67 horsepower torque required on the starting motor if the starting motor were a 900 revolutions per minute motor to correspond with the speed of the set. Then the starting torque of the running motor expressed in terms of horsepower running torque will be $67 \times 1200 \div 900 =$ 89 horsepower torque required on starting motor.

To obtain the energy output from the starting motor in the short period of time, we must know the weight of the revolving parts and the radius of gyration.

For the set under consideration suppose the motor armature weight = 2450 pounds; radius of gyration = .925 feet.

At 900 revolutions per minute velocity $= (2\pi \times .925 \times 900) \div 60 \div 87$ feet per second.

Fly wheel effect on stored energy $= Wv^2 \div 2g = (2450 \times 87^2) \div 2g = W \times 87^2) \div 64.4$.

The D. C. rotor weight = weight of A. C. rotor, then total weight $= 2 \times 2450 = 4900$ pounds.

Assuming same radius of gyration for D. C. generator, the total stored energy $= 4900 \times 87^2 \div 64.4 = 575000$ foot-pounds.

This energy must be stored in one minute by the starting motors. Since 1 horsepower = 33,000 foot- pounds per minute, the horsepower capacity of motor $= (575000) \div 33{,}000 = 17.4$. This is horsepower required to store the energy in the revolving part of the set alone.

Since friction losses will also enter, we must assume a loss due to friction which also must be taken care of by the motor. Assuming the friction loss of each machine in the set to be 2 per cent. we have,

Friction loss = 200 Kw. × 2 (for 2 machines) × 02 = 8 Kw. Since 8 Kw. = 10.7 horsepower, the total horsepower rating of motor $= 17.4 + 10.7 = 28$ horsepower.

This is the horsepower required in motor if designed for 900 revolutions per minute. Since this motor has to bring the set above 900 revolutions per minute in order to synchronize on the decreasing speed, the motor must be 1200 revolutions per minute. The horsepower will then be $(28 \times 1200) \div 900 = 37$ horsepower.

The motor must then be a 37 horsepower machine to dissipate the heat and supply the stored energy and must have a starting torque equivalent to 89 horsepower running torque. This means that the motor must have a starting torque $89 \div 37$ times full load running torque or the starting torque must be two and one-half times full load torque.

This shows the considerations entering into the design of the motor for starting duty. It can be seen that the motor must have a heavy starting torque compared to its normal rated horsepower and this means that the rotor resistance must be designed for the given torque. As the starting motors for simplicity and cheapness are most often squirrel cage motors, the problem in the case is to obtain the desired rotor resistance in the end rings and to give the radiating surface necessary to dissipate the heat. This can be done sometimes by using brass end rings but, when the heat dissipation required with the starting torque is excessive, it is necessary to have a motor with external resistance in the rotor circuit.

The next section of this article will take up test calculations to determine induction motor operating characteristics.

Investment and Fuel Costs, Efficiency and Maintenance of Prime Movers

BY H. G. STOTT, R. J. S. PIGOTT AND W. S. GORSUCH.

FROM time to time various claims are made for the different types of prime movers as regards efficiency and economy. These data are often misleading unless reduced to a uniform basis for comparison. In what follows an interesting comparison of prime movers used with generating units is made and the relative standing of the different types shown on a basis of investment and fuel costs, efficiency, and maintenance. The material is abstracted from a paper presented at the A. I. E. E. annual convention held at Detroit in June of this year.

INVESTMENT AND FUEL COSTS.

In comparing the various types of prime movers, conclusions are often reached, largely from a study of the cost of fuel, without any reference whatever to the total cost of power and the relative investment costs. Investment costs of the units and fuel costs are shown plotted in conjunction with the percentage of normal full-load rating in Figs. 1 and 2, for making an economic study of the various types of prime movers.

The impression that gas and oil power invariably imply a lower cost of generation is constantly losing ground through the critical analysis of the elements of power costs. Fuel is only a fraction of the total cost of power, and there are conditions where it is overbalanced by other costs. Claims have been repeatedly made that steam turbines use two and one-half times the amount of fuel consumed by gas engines, but these statements are without foundation. Before any fair comparison can be made of fuel consumptions, records should be kept over a reasonably long period and the coal reduced to a common basis as to B.t.u. per pound and the percentage lost in refuse.

The curves plotted in Fig. 1 are for small machines of 750-kw. capacity—the steam turbine a single unit costing $15 per kilowatt, the gas engine a single unit costing $73 per kilowatt, and the oil or Diesel engine a double unit costing $95 per kilowatt. These prices are for the prime mover and generator delivered and erected (exclusive of foundations) within 600 miles of the factory. The investment costs are taken at 11 per cent for the steam turbine and 15 per cent for the gas and oil engines. In investment costs are included interest, taxes, insurance and amortization fund, that is, an arbitrary percentage that should be set aside and the percentage corrected, if necessary periodically, so that when the apparatus is condemned on account of obsolescence or inadequacy, there will be a fund which will meet the expense (see "Power Costs" *A. I. E. E. Proceedings,* May, 1913).

Coal for both the steam turbine and gas engine is taken at $3 per ton having 14,500 B.t.u. per lb. delivered alongside the dock. On account of the wide fluctuation in price of the same oil at the same locality, two figures are used, namely, four and five cents per gallon. All auxiliary costs are included, but stand-by costs are not, as these vary widely with the conditions of operation.

Adding the investment and fuel costs for any percentage of normal full load rating, the steam turbine will be found to be slightly less than the gas, and considerably less than the oil engine. Even with stand-by losses allowed, the turbine will still have the advantage over the gas engine loads below 80 per cent full load rating. The investment costs are computed on the normal full-load rating, and if advantage is taken of the overload capacity of the turbine which is approximately 25 per cent for 24 hours, the cost per kilowatt-hour during such periods of maximum capacity will be less than shown by the curve. This does not apply to gas and oil engines, as what little overload capacity may be allowed in these machines is for a short period of two hours or even less.

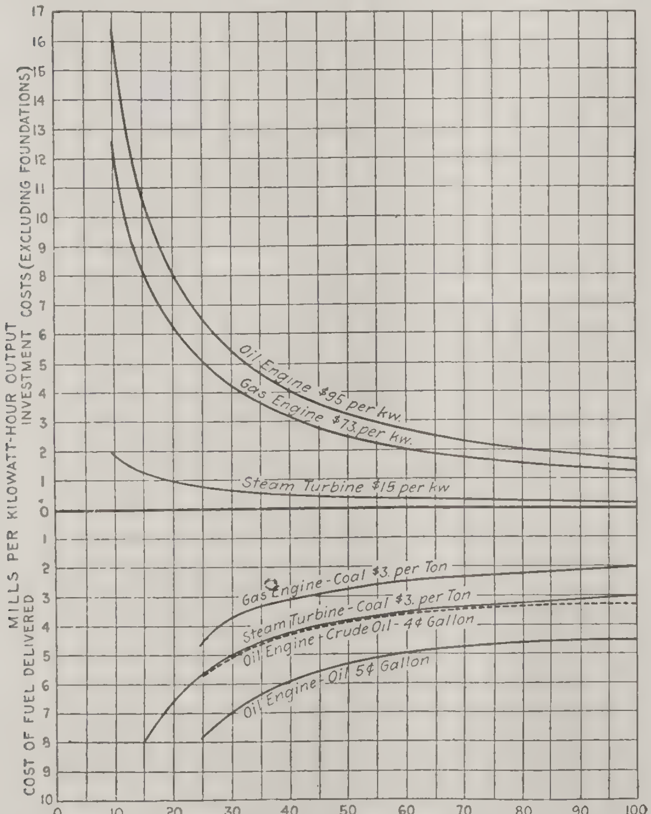


Fig. 1. Relative Investment and Fuel Costs of a 750 KW. Steam Turbine, Gas Engine, and Oil Engine Direct Connected to 60-Cycle Generator Operating at Different Percentages of Normal Full Load.

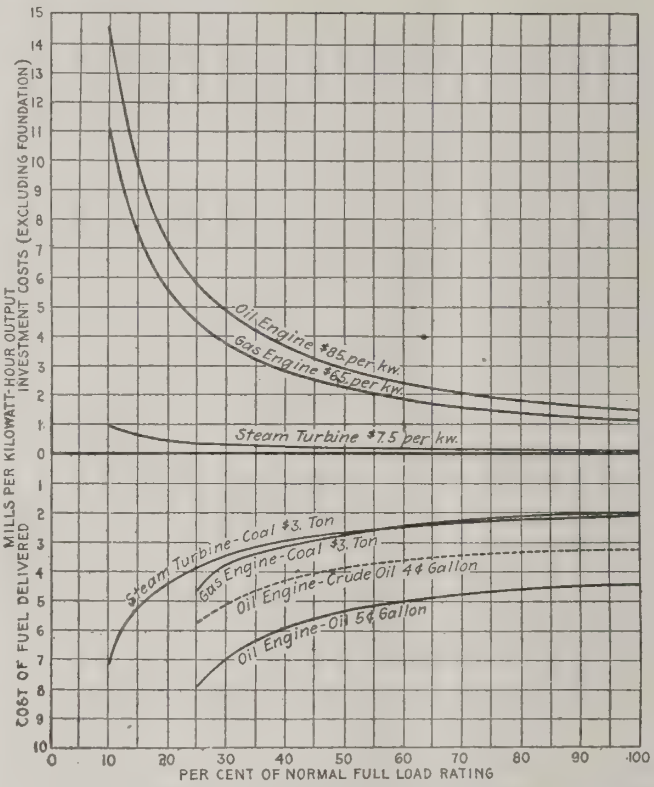


Fig. 2. Relative Investment and Fuel Costs of Prime Movers Direct Connected to 60-Cycle Generators of 20,000 KW. Capacity Operating at Different Loads—Steam Engine, One 20,000 Unit; Gas Engine, 10 Units 2000 KW; Oil Engine, 40 Units 500 KW.

Another set of curves is plotted in Fig. 2, showing a single turbine unit of 20,000-kw. capacity, costing $7.50 per kilowatt, ten 2000-kw. gas-engine units costing $65 per kilowatt, and forty 500-kw. oil-engine units at $85 per kilowatt. In a plant of this capacity, the gas and oil engines are practically out of the running, with these fuel costs. In computing the cost of fuel, the coal was put on the same basis, namely, 10,825,000 B.t.u. per dollar, whereas the oil at 4 cents per gallon is equivalent to 3,718,000 B.t.u. per dollar. This may look as though the steam turbine and gas engine were being favored, but in comparing prime movers as they stand today they must be considered in connection with the prevailing cost of fuel. While it is possible to get a cheaper coal than $3 per ton with 14,500 B.t.u. per lb., it is a question whether many more B.t.u.'s. of natural oil per dollar can be obtained, except in a few localities. If natural instead of producer gas is considered, it would cost about 10 cents per 1000 cu. ft., which is a reasonable figure, as the price varies from 5 to 25 cents per cubic foot, depending upon the location of the well.

At 40 per cent of normal full-load rating, the investment cost for the gas engine is approximately 90 per cent of the fuel cost and for the oil engine using oil at four cents per gallon it is about 80 per cent., whereas with the steam turbine it is only 7 per cent.

If we assume for illustration, that in a small plant it is possible to obtain a horizontal semi-Diesel installation, including engine and generator delivered and erected, excluding foundations, for $73 per kilowatt, and that oil can be purchased for 3.5 cents per gallon delivered, it will be seen from Fig. 1 that while the cost of fuel will be slightly in favor of the oil engine, the sum of the ordinates above and below the axis for any percentage of load will be in favor of the steam turbine. With larger installations it will be seen by referring to Fig. 2 that the turbine has decidedly the advantage. All these illustrations are on the basis of the normal full-load rating of the plant, however, if reserve capacity is allowed for to insure continuity of service, the investment costs for the gas and oil engines will be proportionately higher than for the steam turbine.

From a study of these curves it will be seen that the ratio of cost of steam to gas and oil units is decidedly in favor of the former so that gas and oil power becomes severely handicapped in large work owing to the proportionately greater investment burden. And, unless the price of coal rises materially above the present value, the gas and oil engines will find limited application in stations of any appreciable size, except under very favorable circumstances, where natural gas, by-product gas or some artificial fuel oil can be secured at low prices. If maintenance cost and the additional investment cost required to assure reliability or continuity of service are included, the steam turbine will stand out more prominently.

HYDRAULIC TURBINES.

The redeeming feature of the water turbine, which gives it an advantage over other prime movers, is the absence of fuel. As a result, the operating expenses are practically the same whether the plant is working 10 or 24 hours per day. On the other hand, the investment cost is influenced by the load factor, but it is doubtful in any case whether the water turbine and generator will exceed twice that of the steam turbine and generator on the basis of 11 per cent. When the investments costs include an adequate supply of auxiliary capacity to supplement the deficiency in steam flow, the difference between the investment costs of prime movers plus the fuel costs, at any percentage of normal full load rating, will not be so marked, as the investment costs of the units of the hydroelectric plant will not only be much higher than a straight steam plant, but in addition, there will be fuel costs for the reserve units. In fact, with the same class of service, and the reliability charge in the form of duplication of units or steam reserve, the straight steam turbine units will in many cases be more economical. In low-priced fuel districts the hydraulic turbine is only a competitor of the steam turbine where the development costs are moderate and the load factor reasonably high.

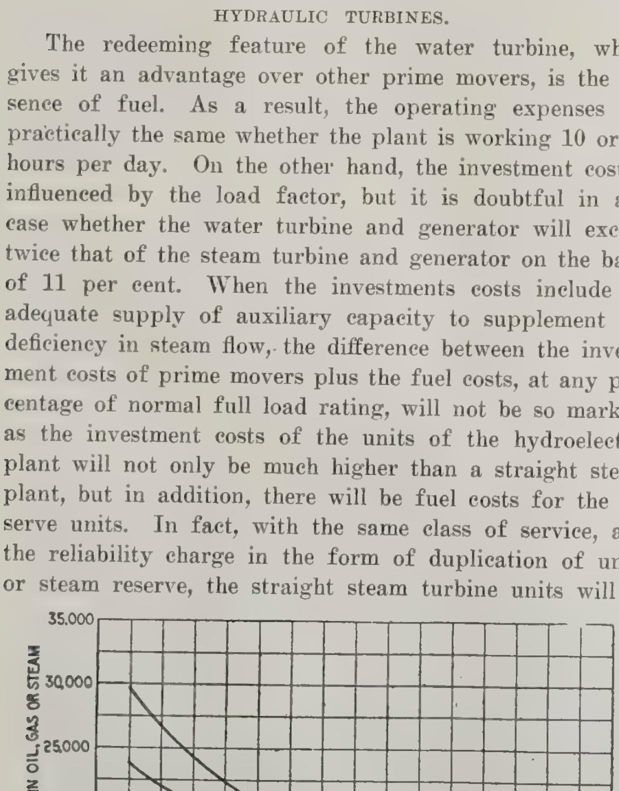


Fig. 3. Rates of Heat Consumption Per KW at Different Percentages of Normal Full Load Rating.

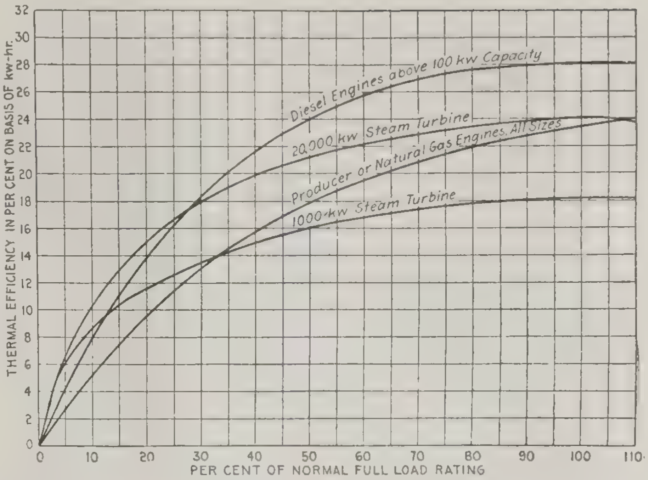


Fig. 4. Thermal Efficiency of Prime Movers With Auxiliaries Not Considered.

More attention is now being given to the important relation between the efficiency and durability of the water turbine than has been in the past. It is the opinion of some engineers that the most efficient turbine, if operated too constantly at low gate opening is likely to show some pitting if the head is high, and they recommend that turbines of high specified speed be kept as closely loaded as possible to the point of maximum efficiency, while with turbines of lower specific speed it is not necessary to operate within such close limits.

The proportion of the total investment cost of a 20,000-kw. plant represented by the prime mover and generator for the various types of units, is approximately as follows:

Prime mover	Total investment cost per kw.	Cost of prime mover and generator per kw.	Percentage of total invest't
Steam turbine	65.00	7.50	15
Gas engine (Producer gas)	140.00	65.00	46.5
Oil engine	120.00	85.00	71
Hydraulic turbine	125.00	12.00	9.6

Considering the different types of prime movers in connection with the total investment cost of the plant, it is evident from a study of curves similar to Figs. 1 and 2, developed on a load factor and total cost basis, that with a very poor load factor the all-important point is to keep down the fixed charges, as they are of vastly greater importance than any possible gain in efficiency due to a better type of prime mover of the same class. This is true of any plant, and the curves will show the futility of attempting to carry peak loads by means of water turbines, gas and oil engines or any prime mover that necessitates a large investment per kilowatt.

EFFICIENCY AND HEAT CONSUMPTION.

Figs. 3 and 4 are presented to show conservative thermal efficiencies and heat consumptions in B.t.u. per kilowatt-hour at different percentages of normal full-load rating, for two sizes of steam turbines and for all sizes of gas and oil-engines, reckoned on the heat in the steam, gas or oil delivered to the throttle valve, and do not include boiler or producer losses or auxiliaries. It is evident that as the larger sizes are approached the inequality between the steam turbine and gas-engine steadily vanishes until finally the former exceeds the latter. It is interesting to note that at normal full-load rating the thermal efficiency of the 20,000-kw. steam turbine, which is based on 175 lb. steam pressure and 100 deg. superheat, is 24.2 per cent, and the producer or natural gas engine 23.8 per cent, both referred to kilowatt-hour output. The average thermal efficiency of steam turbines larger than 14,000 kw. is between 24 and 25 per cent, and the maximum value for very large machines is a little below 25.5 per cent.

An important feature of the steam turbine and especially the oil engine, is that the efficiency does not materially decrease until the load falls below 25 per cent of the normal rating, whereas the gas engine changes rapidly. In small plants with a low load factor, efficiency may be a secondary matter compared with investment cost, and the cost of maintenance and reliability.

MAINTENANCE AND RELIABILITY.

On account of the high mechanical stresses inherent in the gas and oil engines, and heavy reciprocating masses, there is necessarily greater maintenance and repair cost, also a lower reliability of service and a higher class of attendance than for either the steam or water turbine units. The reliability of the gas and oil units has not been sufficiently established to warrant their adoption for reasonably large power stations operating 24 hours daily, without the plant being over-burdened with some type of reserve and consequently excessive investment costs.

Space economy is a factor that affects the investment cost of power, and is especially of very great importance for plants of any appreciable size in large cities or where property is expensive. For different sizes of the various types of prime movers, the number of kilowatts per square foot of floor space occupied, is from 10 to 15 for horizontal steam turbines, and from 0.5 to 0.8 kilowatt for gas and oil engines. Where a number of gas and oil engines are installed and the passage ways included, the contrast will be still greater.

Perhaps the most remarkable fact brought out in this report is shown in Fig. 4, where we find that the large steam turbine has now passed the gas engine in thermal efficiency and the only prime mover surpassing it is the Diesel type of oil engine. The oil engine reaches a maximum efficiency of about 28 per cent as compared to about 24 per cent for the latest type of 20,000-kw. high-vacuum steam turbine, and there is every prospect that at least 26 per cent will be realized before the end of the current year. The present limit in size of the Diesel type engine seems to be about 1800 kw., so that for plants in excess of 15,000 kw. in capacity the number of units and the space occupied by them becomes excessive. Just what their maintenance under the high cylinder temperature will be is dubious, as there are not sufficient data available. Figs. 1 and 2 summarize the whole prime mover situation in the combined curves of investment and fuel costs, as by taking the sum of the ordinates at any percentage of the rated load it will be seen that the steam turbine is far more economical than any other type of heat engine.

A Small Hydro-Electric Plant and Transmission System Near Hot Springs, Va.

BY ARTHUR N. JOHNSON, ELECTRICAL ENGINEER.

A small hydro-electric plant, transmission line and electric railway has recently been completed and placed in operation near Hot Springs, Va., to furnish power for mining, hauling and grinding a fertilizing product known as Travetin. This product is a Marl deposit or ore said to be formed from the action of an extinct volcano and made available as a dissolved limestone precipitate from water that still rushes from same. This ore is being worked into a plant food to sweeten soil and revive worn out lands.

The power project involves several features of interest including the construction of a concrete reservoir at Falling Springs, Va., and the use of a head of 515 feet between this reservoir and the power station located in the creek below leading to the Jackson river. In securing this head a pipe line 6380 feet long has been constructed connecting the reservoir with the power house. Also a transmission line and electric railway 2½ miles long has been built from the power station to the ore quarry.

On account of a fall of more than 100 feet just below the reservoir where a cataract formerly existed, the first section of the hydraulic line forms a stand pipe 116 feet high constructed of 36-inch asphalted spiral riveted pipe made from No. 8 gauge steel in four sections and joined together with forged steel flanges. This stand pipe is made with a special angular opening near the bottom connected by large steel flanges with the first section of the main pipe line. This section is 1200 feet long and made of 22 inch No. 10 gauge spiral riveted pipe in lengths of 40 feet and connected together with steel compression couplings. The extreme head of this portion of the line is 250 feet. Section No. 2 of the pipe line consists of 1240 feet of 20 inch No. 10 gauge spiral riveted pipe with a head of 365 feet at the lower end. Section No. 3 is 3940 feet long of 20 inch No. 8 gauge spiral riveted pipe and connects to the water wheel making possible an effective head of 515 feet. At points where the hydraulic line is carried over ravines, the joints are made with heavy forged steel flanges riveted on the pipe with all other connections made of forged steel compression couplings. There are four bends in the line,

Fig. 1. Small Hydro-Electric Station Near Hot Springs, Va.

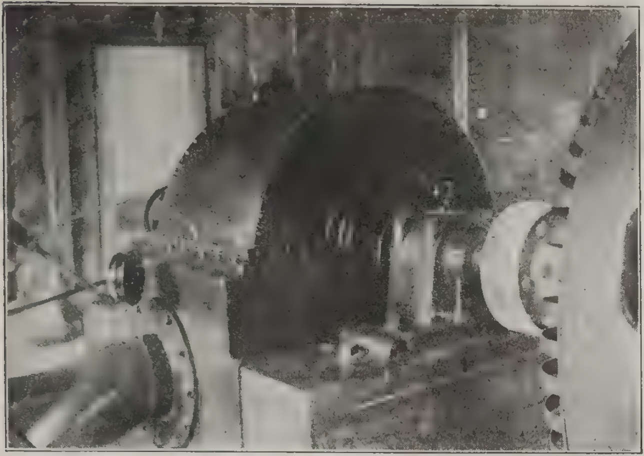


FIG. 2. PELTON WATER WHEEL AND GENERATOR AT POWER STATION.

the greatest of which has a deflection of 40 degrees and these are made of lap welded pipe with forged steel flanges, bent on long radii to reduce friction as much as possible.

The power house shown in Fig. 1, is a wooden structure housing the electrical apparatus installed on a massive concrete foundation. The electrical equipment includes a 500 Kva 3-phase, 60-cycle, 2400 volts, generator direct connected to a high head Pelton water wheel of 600 horsepower capacity operating at 600 revolutions per minute. A 50 Kw. motor-generator set is also installed consisting of a 70 horsepower, 2300 volt, 3-phase, 60 cycle, induction motor connected to a 550 volt D. C. generator. This outfit is used to furnish energy to the electric railway system described later.

To furnish power to the ore quarry, a distance of 2½ miles, and operate the electric railway for ore hauling, a 3-phase transmission line and trolley line has been constructed. The transmission line and trolley line is built on 35 foot poles, the former being constructed of No. 6 copper and the latter of 3-0 trolley wire. A 336,000 circular mil aluminum feeder for the trolley line uses the same poles as the high tension line. The trolley line is shown in Fig. 3 as well as the type of electric locomotive used. The poles are spaced 75 feet on straight lines and 25 feet on curve.

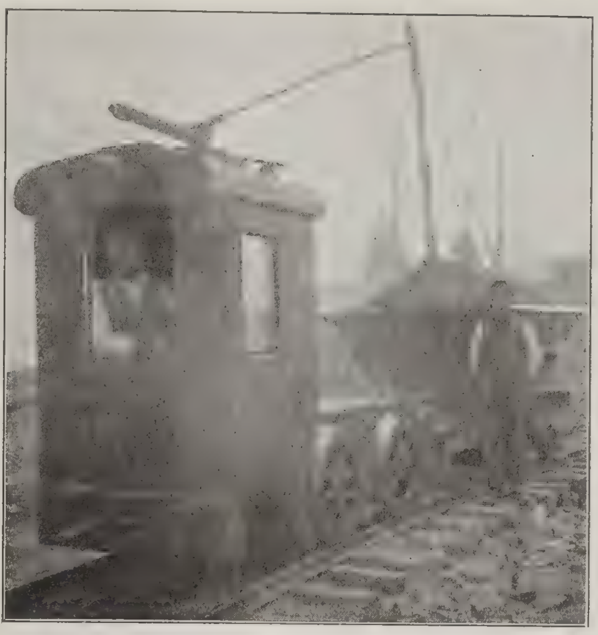


FIG. 3. SIX TON JEFFERY ELECTRIC LOCOMOTIVE USED TO HAUL TRAVETIN ORE.

A 5/16 inch guy wire is used for guying and a ⅝ inch galvanized guy wire for the trolley line spans. Wood strain insulators are used on the spans and ball insulators on the guys.

On account of the rough route covered by the transmission line and trolley line over high rugged cliffs and precipices with grades ranging from zero to 6½%, certain difficult features of construction were encountered in constructing the electric lines, the rise being over 300 feet in the 2½ miles. The transmission line is designed for 2300 volts and all motors used are of this voltage and of the induction type. For lighting, transformers are used and this voltage stepped down. The electric railway operates at 550 volts, the energy being supplied from the motor generator set as already mentioned. Six-ton electric locomotives are used to haul the ore cars of the type shown in Fig. 3.

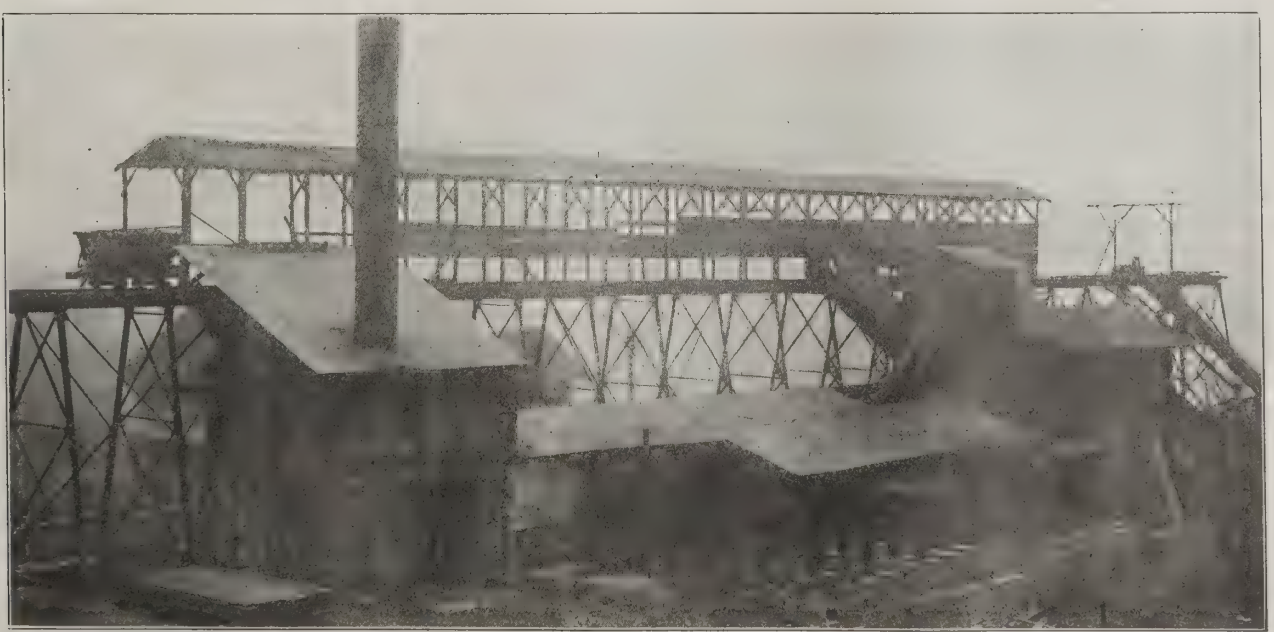


FIG. 4. TIPPLE AND DRYER OF THE OHIO C. BARBER FERTILIZER CO. AT FALLING SPRINGS, VA.

The equipment at the quarry consists of a motor operated pulverizer operating on the ring principle and driven at a speed of 600 revolutions per minute. A gyratory crusher is also installed for reducing rock driven by a 100 horsepower induction motor. A rotary dryer is also installed together with a swinging hammer pulverizer driven by a 100 horsepower motor.

The crusher is shown in Fig. 5 and the tipple and drier in Fig. 4. The capacity of the entire plant is 100 tons of dry pulverized Travetin per day.

The electrical equipment installed in the plant was furnished by the Westinghouse Electric & Mfg. Co.; the electric locomotives which are six tons machines operated by 2-20 horsepower, 550 volt motors connected parallel, were furnished by the Jeffery Mfg. Co., of Columbus, Ohio., and the cars used to haul the ore by the Atlas Car & Mfg. Co., Columbus, Ohio. The pipe for the main pipe line was furnished by the American Spiral Pipe Works, of New York City. The entire plant was constructed and is now operated by the Ohio C. Barber Fertilizer Co., of Akron, O., of which company Mr. L. M. Latta is general manager at Hot Springs. The electrical installation was designed and installed by the writer, including the feeder, trolley and high tension line and the electrical power plant. Special attention has been given to lightning protection and a signal system for all grade crossings installed.

Fig. 5. Gyratory Crusher Driven by 100 Horsepower Induction Motor at Quarry.

Some Problems Met and Solved by an Electrical Trouble Man

BY J. A. HORTON.

A Typical Trouble Job and Some Other Troublesome Conditions.

An inspector was once called in to locate the trouble with a motor that would run for only a couple of hours, when it would have to be shut down to keep it from smoking. The motor was used for blowing the dust from the tumbling room of an iron foundry. To keep dust out of the motor, which was of the open type, a housing had been built around it, the dimensions of which barely exceeded those of the motor and of the belt guard. There was a small ventilation hole in the top of the housing but none at the bottom. The commutator was worn into three ridges, 1/8 inch deep, and corresponding brushes all tracked. There was no end play and the brushes had worn so short that many of the hammers rested upon the holders instead of upon the brushes and the commutator mica was high. The brushes were incorrectly spaced because the holders, of which there were three per stud, were at different distances from the commutator, resulting in throwing the brushes out of alignment. On starting the motor the sparking alone suggested sufficient reason for the heating of at least the armature. One of the field lugs was also pressing against the motor frame but this in no way affected operation because there was no other low-resistance ground on the circuit. It did, however, qualify the motor frame to shock anyone standing on the cement floor and touching the motor, because the frame was not well grounded.

As it was useless to seek any inevident cause of sparking when there were so many evident causes to correct, the inspector removed the armature, turned the commutator and grooved the mica. He then removed the copper burrs incident to turning. The linings and housings were emptied, cleaned and the oil wells refilled and the armature reinstalled. All of the brushholders and studs were wiped free of carbon, copper dust and oil and new brushes installed. All holders were set equidistant from the commutator and all brushes of the same stud were alined to toe the same commutator bar. The holders of alternate studs were staggered so as to distribute the brush pressure over the whole wearing surface of the commutator and to further distribute the brush pressure uniformly, the pressure springs were eased one notch over the commutator zones that were wiped by the most brushes. The brushes were set to the correct count and carefully sandpapered to fit the commutator curvature. After doing all this the inspector naturally looked for improvement in operation but he was much discomfitted, upon starting the motor, to find that the sparking was almost as bad as it was before.

The local electrician was inclined to believe that the sparking was a little worse than it was before, under load, altho there was no sparking at no-load. This showed that the motor at least had a no-load neutral and suggested that the interpoles might be involved in the sparking under load. The motor had four shunt field coils but had only two commutating coils and the worst sparking was at two brushholders. Inquiry disclosed that the motor had been received with connections made for counter-clockwise rotation while it was operating clockwise. The shunt field had been reversed to obtain the opposite direction of rotation but in changing the brushholders, so that they would trail with the new direction, one pair of interpole leads had, in some unaccountable manner, become reversed. The electrician stated that the motor had sparked from the very first. This reversal had been really responsible for all of the sparking because it had pitted the bars, thereby hastening the raising of the mica.

The trouble was further aggravated by the fact that the motor was operating under continuous overload, which, in conjunction with the temperature-raising qualifications of the enclosing structure, accounted for most of the overheating. It was not advisable to remove the housing because grit would then have had free access to the commutator to prevent its taking a polish. To let cool air in under the motor without letting in the dust, two boards were removed from just above the floor line of one side of the housing and a long perforated wooden box installed full length of the opening. Two wires were run the full length of the box and over the wires were hung thin veils of waste to stop the dust. By stopping the sparking and properly ventilating the motor, its maximum temperature was lowered 20 degrees.

Ventilating Ducts Clogged.

One design feature that has contributed its share toward the reduction of pounds weight per horsepower of modern dynamos and motors, is the efficient ventilation that characterizes them. It is as important that generated heat be carried away as it is that excessive heat be not generated and proper provision for the former helps the latter. By a well developed system of ventilating ducts and by fanning actions incident to armature rotation, the modern designer directs a flow of cool air where it will do the most good. If the ducts provided for air circulation become clogged, the whole ventilation scheme fails and the temperature of the involved device must rise.

Typical instances of excessive heating due to impeded air circulation, are as follows: An operator of a cotton mill filed the time-worn complaint that several of his induction motors were "so hot that you can't put your hand on 'em." An inspector called and ascertained that the motors, all of which were in the same room, were free from grounds, short-circuits, rubbing rotors, hot bearings and duty overloads. He further noted that similar motors operated in the other parts of the mill, ran cooler, altho they had been in service longer. With a slip of thin paper held between thumb and forefinger and applied to the frame ducts, he determined that there was no air issuing from them. Investigation revealed that the air-ducts of both the rotor and the stator of all of the affected motors, were practically closed by an accumulation of the lint that characterizes certain textile operations. Cleaning of the ducts stopped the heating.

In another case when called to change the connections of a 110 volt repulsion induction motor, to connections for 220 volt operation, he noticed that the armature heated much more than the fields. (As a rule the reverse is true.) The armature was of the usual continuous current fully ventilated type in which there is a clear passage from one end to the other through the core and the commutator, a flow of air entering at both ends and passing out thru a system of armature core and field core ducts that are entirely in line with each other. He removed the armature, stood it on end and bounced it, thereby dislodging about two pounds of a fine powder that represented a part of the production of the machine to which the motor was connected. Application of compressed air with a hose, loosened a pound or more of the powder. The circulation of the air thru the core of the armature had been entirely stopped by the accumulation of the powder much of which had been rendered gummy by the action of the heat. On thoroughly cleaning the armature and the frame ducts, reinstalling the armature and operating it at the usual load (a little more than rated full load) for five hours, there was no further evidence of excessive heating.

Juggling Field Coils.

In Fig. 1 two types of field coils are shown which can be installed end for end or up-side down, without the appearance of the lugs suggesting any irregularity. The full line lugs illustrate the type on which the lugs are located in the centers of the ends. The dotted lugs are those of a coil, the lugs of which are located in the centers of the sides. In either case the appearance of the lugs is the same irrespective of the position in which the coil may be installed. An operator complained that the voltage of his alternator had been low "Ever since she was disassembled for overhauling after a flood." The trouble was so evidently due to reversal of some of the field coils, that he was instructed as to how to test their polarity and was further told that any coil found to be wrong, should be turned end for end, but he was not instructed as to manner of doing this. The idea of the instructions was to have the lugs exchange places. The operator instead of simply turning the coil around in its own plane, turned it completely over. This reversed the order in which the current entered and left the coil, but due to the coil being turned over, it simultaneously caused the current to circulate

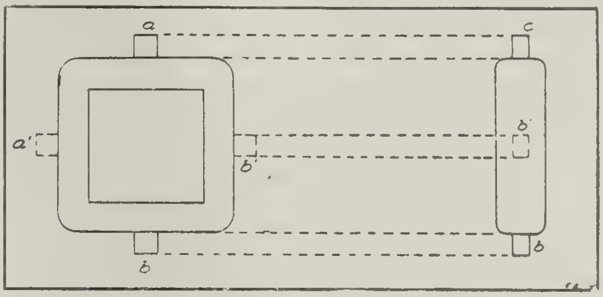
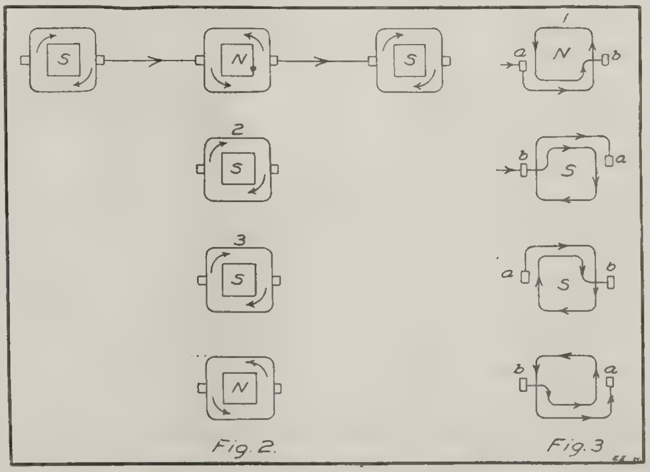


FIG. 1. TWO TYPES OF FIELD COILS SHOWING ARRANGEMENT OF LUGS.



FIGS. 2 AND 3. SHOWING WAYS OF REVERSING FIELD COILS AND EFFECT ON POLARITY.

around the coil in the opposite direction thereby maintaining the original polarity. In other words, he had reversed the polarity twice which, of course, kept it the same and kept it wrong. If he had turned the coil over on its lugs as trunnions, everything would have been alright. This point is brought out by means of Figs. 2 and 3.

In Fig. 2, the arrows indicate the direction of current circulation: (1). With the coil in its original position. (2). With the coil turned end for end without turning it over. (3). With the coil turned over on its own lugs as trunnions. (4). With the coil turned over in such a manner as to exchange the position of its lugs. It is to be noted that the methods of (2) and (3) reverse the polarity of the coil while that of (4), the method used by the operator does not. These relations are easily developed as indicated by the diagrams of Fig. 3, in which (1) shows the direction of current circulation with the coil in its original position. If (1) be drawn upon thin paper, so that the lines may be seen thru the paper when it is turned over, just as a field coil is turned over, the reversals of the current circulation, hence of polarity, can be readily demonstrated. When right side up with lug *a* to the left, as in (1), the circulation is counter-clockwise. Upon turning the paper (coil) end for end, thereby interchanging the positions of *a* and *b*, (2), the circulation then becomes clockwise. Upon restoring the paper to the position of (1) then turning it over on lugs *a* and *b* as truuions, (3) the circulation again becomes clockwise. If, however, instead of turning the coil over on *a* and *b* as trunnions, it be turned over in such a manner as to have *a* and *b* exchange places, (4), the circulation, hence polarity, remains the same as in (1), because, simultaneously the coil has been turned end for end (2), thereby reversing its polarity once, and turned on its lugs (3), thereby reversing its polarity again, the next result being to maintain the original polarity of position (1).

Some Handy Tools for the Wireman

BY JAMES A. PERRY.

Where wires heavier than No. 12 or 14 are being installed in cleats, a tightening device arranged somewhat as shown in Figs. 12 and 13, will be useful. Aside from the fact that it is a time saver, this arrangement has the advantage that the conductors can be pulled very taut without the damage to insulation which usually occurs when an endeavor is made to tighten conductors with pliers. The device comprises (Fig. 12) a 2-inch x 4-inch lever, about 4 feet long, with a slot cut in its end. Adjacent to, and parallel with, the slot a block possibly 5 inches long and 2 inches square is fastened with flat head screws. A cleat is screwed to this block as shown. This cleat may be either of porcelain, similar to those being used on the job, or preferably it can be cut out of wood (maple) or hard fiber. The wire hole in the cleat should lie directly over the end of the slot.

In using the lever its upper end is placed against a beam or some other member of the building that can be used as a fulcrum, and the conductor firmly clamped in the cleat. Pressure on the lever tightens the conductor. If the conductor cannot be drawn sufficiently tight with the lever in its first position on the beam which forms the fulcrum, the upper end of the fulcrum can be blocked out from the beam, whereby ample leverage will be provided.

A great deal of time is wasted by men that do not know how, in cutting flexible tubing. A majority of wiremen appear to use a knife. Probably the best method of cutting this material, except possibly the very large sizes, is with the pliers. The smaller sizes can be nipped asunder with the large size cutting pliers almost as readily as can a wire. The tubing is thereby flattened, but it can be readily re-formed to its normal shape with the fingers. Tubing of larger diameters, which will not go between the plier jaws, can be nipped in two with the oblique pliers by first flattening the tubing with the fingers and cutting a hole, and then completing the cut around the entire circumference using the pliers as one would shears.

Large porcelain tubes are difficult to cut without cracking. They can, however, be cut, if an emery wheel is available, by grinding a circumferential groove as shown in Fig. 14. After the groove has been cut, the tube will readily break around it, if it is held by the two hands and subjected to a bending force. After it is in two, the rough edges at the ends of the tube can be rounded on the side surface of the abrasive wheel. It is easy enough by using this method to cut a large tube in two in 60 seconds, more or less.

Almost every wireman knows how to make a drill for forming holes in brick work or adobe, from a piece of conduit or pipe. Most of them, however, do not appear to understand how the teeth of the drill can be formed so that the drill will clear itself, that is, so that it can be withdrawn from the hole without binding.

The teeth in a conduit brick drill are cut, as shown at Fig. 15, *B*, with a three-cornered or half-round file. Although it appears inconsistent, the work can be done better and quicker with a half-round file than with a three-cornered one. Where files are not available, a hack saw can be used for cutting the teeth, but this tool is not as good as a file because of the liability of breaking the hack saw blades. After the teeth have been cut, the end of

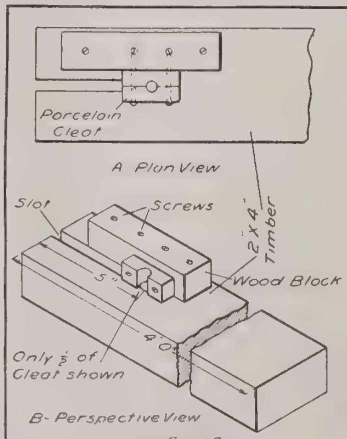


Fig 12

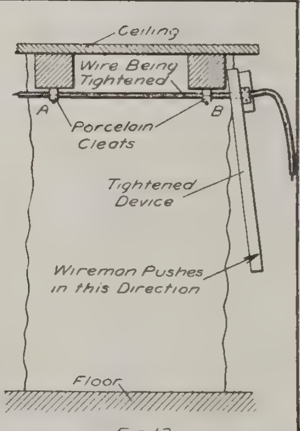


Fig 13.

Fig. 12. Device for Tightening Large Sized Wires.

Fig. 13. Application of Wire Tightening Device.

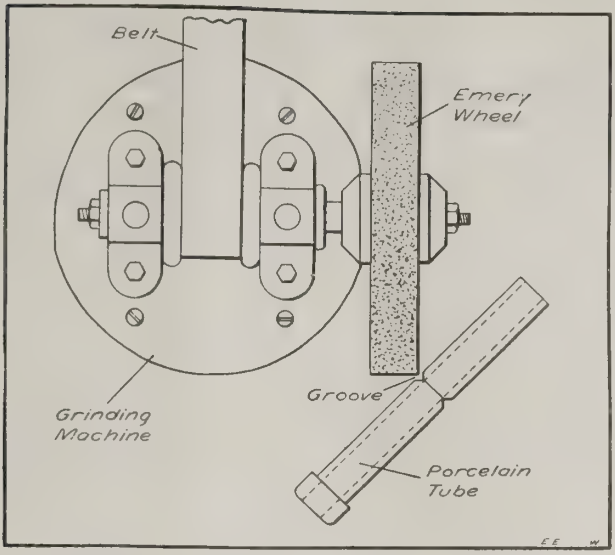


FIG. 14. CUTTING PORCELAIN TUBES.

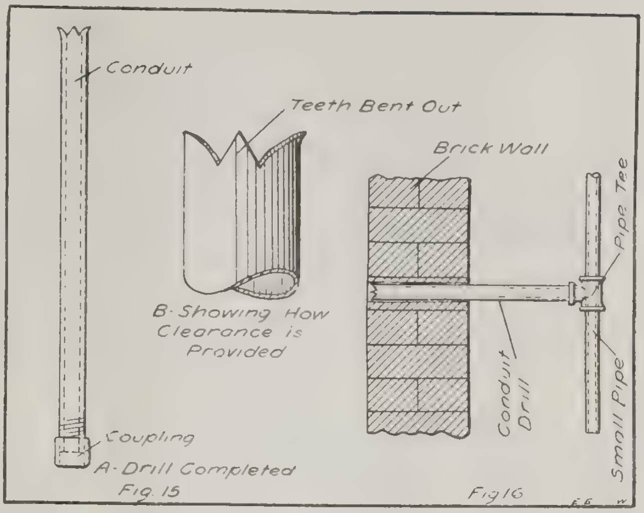


FIG. 15. A BRICK DRILL OF CONDUIT. FIG. 16. REMOVING BRICK DRILL FROM A WALL.

the drill can be held projecting about ¼ inch over some solid object, and the ends of the teeth spread out, possibly 1/16 in. beyond the normal surface of the conduit, with the ball end of a ball-peen hammer.

It is always a good scheme to thread the end of a conduit brick drill and run a coupling on it as shown at *A*, Fig. 15, to protect the thread. In spite of all precautions, these drills will sometimes bind in a hole. If one does, and its end is threaded, the protective coupling can be removed and a pipe T run on as shown in Fig. 16. Then a length of pipe of a smaller diameter is pushed through the open holes of the T. This short pipe can be used as a lever whereby the drill can be turned in the hole and loosened, or one can pound against the short pipe and thereby force the drill from the hole.

For drilling in concrete or masonry harder than brick, a drill of the type suggested in Fig. 17 is best fitted. This is forged from hexagonal tool steel stock. The cutting edge of the drill is formed somewhat like that on a cold chisel except that it should be rounding, and that clearance should be provided as suggested. In using this drill its head is pounded with a heavy hammer and the drill is turned a portion of a revolution between each blow. This will tend to make a cylindrical hole and prevent the drill from wedging in it.

Wherever many holes are to be drilled in concrete, either an air or electric drill should be purchased. The justification for such an investment can be readily shown if one figures the cost of labor for drilling with a machine, and then the cost for hand drilling.

It is often necessary to bore holes in locations where the ordinary brace cannot be used. Examples are the holes that must be bored in pockets in finished building wiring through joists of floor plates. If the wireman will carry in his kit a door knob or valve wheel (Fig. 18) he can turn an ordinary bit with one of these handles, and so cut holes in these restricted places. For a permanent tool, probably a door knob, Fig. 18 *B*, is best. Its rounding smooth surface fits the palm of the hand, and the bit can be firmly held in it by the screw that is always provided in the metal part of the knob. A V-shaped groove should be filed in the shank of the bit, into which the end of this tightening screw can engage. For a satisfactory operation of these handles the bit should be kept very sharp.

An operation that is usually very tedious is the fishing of electric fixtures. This is particularly true when wires must be drawn through small diameter arms that are formed into right angle curves. A splendid home-made device for getting a pulling-in wire through these irregular arms can be made as shown in Fig. 19. A piece of fishing line is tied to the end of a length of bead chain, such as that used for pull-chain sockets. It will be found that when the chain is inserted into the tube that it will follow all of the curves very readily, and draw in the fishing line. The fixture wires can be easily attached to this line and then pulled into place. The bead chain will even pass around a right angle curve.

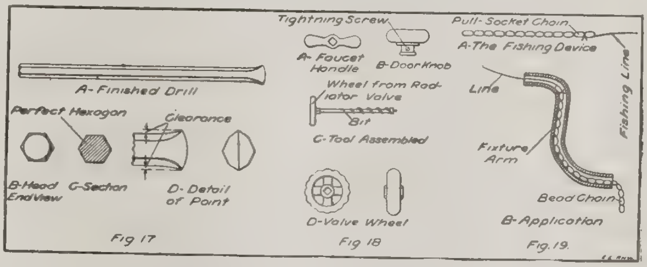


FIG. 17. DRILL FOR CONCRETE OR STONE. FIG. 18. HOME-MADE BORING TOOL. FIG. 19. BEAD CHAIN FOR FISHING FIXTURES.

Another method that can be used for fishing fixture arms if bead chain is not available, is as follows: The end of a length of strong thread is rolled with the fingers into a little ball. This ball is placed with the end of the thread extending, into the fixture arm. Then by blowing into the arm the ball will be forced through, and the thread can be fed in after it. With the thread a stronger piece of twine or a small wire to serve as a pulling-in line, can be drawn in.

Benjamin Franklin was a pioneer in his investigation of natural electrical phenomena. He invented the lightning rod; coined the terms "positive" and "negative" and established the "one fluid" theory of electricity. He was an American.

Concerning the Electrical Trade

News of Activity by Manufacturers, Jobbers, Dealers, Contractors and Engineers.

ELECTRICAL SUPPLY JOBBERS MEET AT BIRMINGHAM, ALA.

Oscar C. Turner, President Turner Electric Supply Company in Charge of Arrangements.

The City of Birmingham, Alabama, is the home of two factors well known to the electrical supply trade of the South, one a regulation jobbing house and the other a manufacturers sales agency. The former is known as the Turner Electric Supply Company and the latter the Robertson Sales Company and the following information refers to the heads of these organizations.

While Birmingham boasts of furnishing a candidate for president of the United States in the last election, who has been a member of the House of Representatives for twenty years, a majority leader of the House now elected to the Senate, it also claims through adoption with no less pride a nationally known "Booster of Things Electrical," the eighth Jupiter of the Jovian Order and an optimist of the first order, Mr. Oscar C. Turner, President of the Turner Electric Supply Co. As a proof of his right to the title "Booster of Things Electrical," we call attention to the fact that he is one of the organizers and now president of the Dixie Club, an organization of Southern jobbers and largely responsible for securing for Birmingham the annual meeting of Electrical Supply Jobbers Association to be held the 8th, 9th, and 10th of this month. This is the first annual meeting of this national organization to be held in the South and with Mr. Turner in charge of entertainment as chairman of the committee on arrangements, it is practically certain that Birmingham will get the credit for another noteworthy achievement at his hands.

OSCAR C. TURNER, PRESIDENT TURNER ELECTRIC SUPPLY COMPANY.

Mr. Oscar C. Turner was born in Atlanta, July 1st, 1874, raised an Atlantian, and started in business an Atlantian but in some way he lost the Atlanta "spirit" and developed a bad attack of the Birmingham "boost" as anyone South and that means nearly every electrical supplier or buyer, will substantiate, for when he is not boosting the electrical game. he is a walking delegate for Birmingham's industries, Birmingham's Chamber of Commerce, and Birmingham's aspirations, local, state and national, rarely however, does he seek honors for himself but for others.

Mr. Turner started in electrical work immediately after graduating from college, as an employe of the Georgia Gas Light Company of Atlanta, for which company he was later made purchasing agent. He resigned this position to take over the wiring business handled by the company and, together with his brother W. W. Turner, conducted an electrical contracting and supply business under the name of Turner Brothers until 1896, when he sold out to take charge of the contract and construction department of the Atlanta Railway Company, then controlled by Mr. Joel Hurt of Atlanta. He held this position until the company was merged with a competing company. Mr. Turner then became connected with the Western Electric Co., as traveling representative and after two years was made manager of the apparatus department of the Cincinnati office, which position he held for two and a half years, leaving to become vice-president and general manager of the Southern Electrical Co., electrical jobbers, at Nashville. He remained in this position for four years when he was appointed general manager of the Warren Electrical Specialty Co., manufacturers of Peerless lamps at Warren, O. After two years in this position he resigned to purchase an interest in the Birmingham branch of the Wesco Supply Co., this company then doing a small supply business in Birmingham. He re-organized the branch in 1909, calling it the Southern-Wesco Supply Co. In the early part of 1913, Mr. Turner secured a controlling interest in the company and reorganized it under its present name of Turner Electric Supply Company of which organization he is president, with Mr. J. J. Fitzsimmons vice-president, W. N. Bowles secretary and J. D. Turner treasurer. The company handles the following lines of electrical apparatus and supplies:

Rigid Conduit—Galvanite and American:— American Conduit Manufacturing Co., Pittsburgh, Pa.

Flexible Conduit—Duraduct:—Tubular Woven Fabric Co., New York City.

Wire and Cable:—Hazard Manufacturing Co., Wilkes-Barre, Pa.

Fuses, Cutouts, Outlet Boxes, etc.:—Chicago Fuse Mfg. Co., Chicago, Ill.

Line Material:—General Electric Company, Schenectady, N. Y.

Sockets, Receptacles, Entrance and Push Switches, etc.: —General Electric Company, Schnectady, N. Y.; Pass and Seymour, Solvay, N. Y.; Bryant Electric Co., Bridgeport, Conn.; Hart and Hegeman Mfg. Co., Hartford, Conn.

Heating Devices and Fans:—General Electric Company, Schenectady, N. Y.; Menominee Electric Mfg. Co., Menominee, Mich.

Bells, Telephone and Telegraph Instruments:—Menominee Electric Mfg. Co., Menominee, Mich.

Tungsten Lamps:—Peerless Lamp Division, National Lamp Works G. E. Co., Warren, O.

Also a full line of Automobile Accessories.

Mr. Turner is a member of the Elks Club, the Country Club, Birmingham Motor and Country Club, president of the Dixie Club, officer of Rotary Club, first vice-president of the Chamber of Commerce of Birmingham, and director of the Board of Trade, Business Men's League and State Fair Association.

L. M. Robertson Heads Birmingham Sales Agency.

From a newspaper career to promoting the sales of fourteen separate and distinct lines of electrical apparatus for as many different manufacturing companies, is a good big step. Yet after all, the qualifications for the first case are a decided asset in the second, in these days when publicity methods and sales methods are so interwoven that it is difficult to tell where the one leaves off and the other begins. Such a step was taken by Mr. L. M. Robertson, the subject of this sketch. After being born at Pleasant Hill, Mo., in 1882 and nurtured in the usual fashion for 17 years, a desire for something to do resulted in a connection in the business department of the *Pittsburgh Times*, now the *Gazette-Times*, during the years of 1899 to 1903. During the latter year, when the position of manager of the Chicago office of the Bell Pottery Company was open, Mr. Robertson promptly solicited and secured the connection. On January 1, 1906, he resigned to become secertary and treasurer of the United States Electric Porcelain Company at Findlay, Ohio, this being one of the plants of the Bell Pottery Company and devoted to the manufacture of porcelain insulators. This marked his entrance into the electrical sales field.

In the spring of 1907 Mr. Robertson came South and selected the city of Birmingham, Alabama, as headquarters for activity as a sales representative for the United States Electric Porcelain Co., and several other electrical manufacturers. He conducted this work under his own name until January first of this year, when the business was incorporated under the name of Robertson Sales Company. Mr. Robertson is president and treasurer of this organization and his brother, Mr. F. A. Robertson, whom he had interested in the work two and a half years previous, vice-president.

The Robertson Sales Company claims as its territory the states of Texas, Louisiana, Mississippi, Alabama, Tennessee, Georgia, Florida, North and South Carolina, and its traveling men call on all the electrical supply buyers in this field. The following electrical lines handled in the interests of the companies named have, with a few exceptions, been introduced in the South by Mr. Robertson, which fact adds considerable credit to the success he is now having as a result of earnest and thorough sales work.

Insulated Copper Wire:
    Detroit Insulated Wire Co., Detroit, Michigan.
Enclosed Fuses and Fused Switches:
    Detroit Fuse and Mfg. Co., Detroit, Mich.
Rigid Iron Conduit:
    Enameled Metals Company, Pittsburgh, Pa.
Flexible Non-Metallic and Armored Conduit:
    Eastern Flexible Conduit Co., Brooklyn, N. Y.
Flush Switches, Receptacles, Switch and Outlet Boxes, Cutout Boxes and Cabinets:
    Cutter Electrical and Mfg. Co., Philadelphia, Pa.
    Steel City Electric Co., Pittsburgh, Pa.
    Allsteelequip Co., Aurora, Ill.
Panelboards, Switchboards and Knife Switches:
    Trumbull-Vanderpoel Electric Mfg. Co., Bantam, Connnecticut.
Measuring Instruments and Bell Transformers:
    Dongan Electric Mfg. Co., Detroit, Mich.

L. M. ROBERTSON, PRESIDENT ROBERTSON SALES COMPANY, BIRMINGHAM, ALA.

Porcelain Insulators, Insulating Products, Insulating Varnishes, etc.:
    National Electric Porcelain Co., Carey, Ohio.
    Chicago Mica Co., Valparaiso, Ind.
    Sterling Varnish Co., Pittsburgh, Pa.
Dry Batteries and Brush Carbon:
    Stackpole Carbon Co., St. Marys, Pa.
Soldering Flux, etc.:
    Burnley Battery and Mfg. Co., North East, Pa.

Mr. Robertson is a member of the Country Club, Southern Club, Newspaper Club and Chamber of Commerce, all of Birmingham, and is a Jovian. In 1907 he married Miss Mary Ashbaugh, of Freeport, Pa., and they have one child.

Selling at a Profit.

Selling goods without profit is injurious to manufacturer, jobber, retailer and consumer.

It destroys reputation, depreciates quality and leaves ruin and demoralization in its path.

It is the father of deception, misrepresentation and business hypocrisy.

It creates strife, discord, distrust and dishonesty.

It opens the doors of bankruptcy and closes the gates of opportunity.

It deprives honest effort of reward and puts a premium upon lying inconsistency.

Its pernicious influence forces to a common level.

Don't cut—stick to your prices!

—The Dodge Idea

New Business Methods and Results

Representing Interests of Central Stations, Electrical Jobbers, Dealers and Contractors.

Suggestions to Dealers and Central Stations for Securing Christmas Heating Device Business.

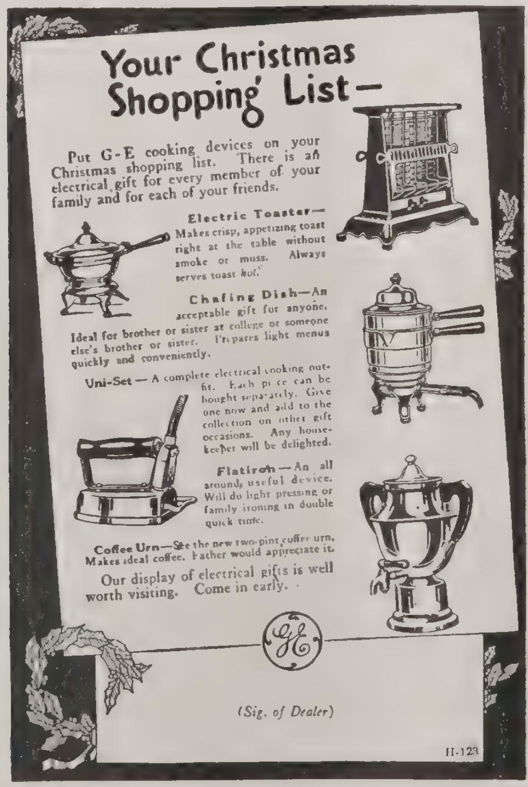
The example set by dry goods stores, toy shops, hardware dealers, confectioners and the like at Christmas time in the way of window decorations, special displays and newspaper advertising, is being followed by progressive electrical dealers with results proportionate to the originality and thought put into it. The opportunities for the electrical dealer and central station new business manager to increase sales of electrical appliances during the Christmas season are equal to, if not greater than those of the average merchant for the prevailing desire with the gift buyer at this time is to secure something useful but out of the ordinary. Electrical devices appeal to the shopper especially from this standpoint so that the possible business depends largely upon ways and means for suggesting these devices as gifts.

The obvious way of making use of this latent appeal in electrical devices is through proper display, a display that will take advantage of the wandering gaze of gift searchers as they pass the windows of the shopping district and present gift suggestions to those who are less energetic as regards searching but can be reached through the display columns of their daily newspaper. Manufacturers of heating devices are keenly alive to the possibilities in both these directions and in a number of cases have prepared systematic campaigns and assistance to those dealers who will handle their goods. Suitable display advertising copy has been prepared by experts and illustrated so as to have a strong suggestion and appeal. Examples of such advertisements with space provided for the dealer's name are shown here.

In regard to Christmas merchandising, Mr. W. M. Stearns, manager of heating device sales of the General Electric Company, formerly of the Atlanta office, has the following to say in a Christmas suggestion number of the Company's Electrical Advertiser: "Systematic methods of ordering and selling electrical heating devices are fully as important as the preliminary publicity planning. The electrical dealer and central station manager should capitalize the present, commendable tendency of 'Do your Christmas shopping early,' which is now profitably recognized by the experienced merchant.

"The advantages of such methods both to the dealer and to the purchasing public are obvious and the central station manager has the added incentive of obtaining increased revenue on idle day circuits. Electrical heating devices are now so well known that they are considered as standard commodities. Their extensive introduction and successful application as domestic conveniences have resulted in their merited recognition as household necessities. They are practical and economical in operation and afford all the advantageous features of electric service.

"The seasonable display must include an attractive and suggestive presentation of goods to the public. The G-E



Your Christmas Shopping List—

Put G-E cooking devices on your Christmas shopping list. There is an electrical gift for every member of your family and for each of your friends.

Electric Toaster—Makes crisp, appetizing toast right at the table without smoke or muss. Always serves toast *hot.*

Chafing Dish—An acceptable gift for anyone. Ideal for brother or sister at college or someone else's brother or sister. Prepares light menus quickly and conveniently.

Uni-Set—A complete electrical cooking outfit. Each piece can be bought separately. Give one now and add to the collection on other gift occasions. Any housekeeper will be delighted.

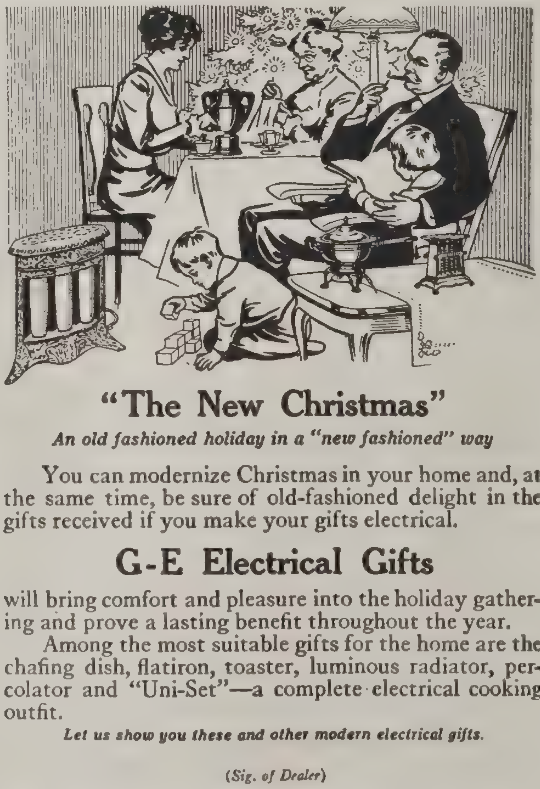
Flatiron—An all around, useful device. Will do light pressing or family ironing in double quick time.

Coffee Urn—See the new two-pint coffee urn. Makes ideal coffee. Father would appreciate it.

Our display of electrical gifts is well worth visiting. Come in early.

(Sig. of Dealer)

H-123



"The New Christmas"

An old fashioned holiday in a "new fashioned" way

You can modernize Christmas in your home and, at the same time, be sure of old-fashioned delight in the gifts received if you make your gifts electrical.

G-E Electrical Gifts

will bring comfort and pleasure into the holiday gathering and prove a lasting benefit throughout the year.

Among the most suitable gifts for the home are the chafing dish, flatiron, toaster, luminous radiator, percolator and "Uni-Set"—a complete electrical cooking outfit.

Let us show you these and other modern electrical gifts.

(Sig. of Dealer)

SUGGESTIONS FOR LOCAL NEWSPAPER ADVERTISING TO BE USED BY DEALERS DURING CHRISTMAS SEASON.

electrical appliances are furnished in cartons with holly paper wrapping sealed with monogram posters which afford excellent opportunities for suitable window decorations. Electrotypes, lantern slides, publications, car cards and posters are furnished free to dealers and central stations selling G-E products. The heating device display stand which is offered at actual cost price is another sales help which will prove especially efficient during the approaching holiday season for attractively displaying heating appliances. The electrical dealer who uses this occasion to accept the opportunities presented cannot fail to extend and receive 'A Merry Christmas.'"

Merchandising assistance of this character is a decided help to the average dealer and it should result not only in making his Christmas business profitable but should stimulate sales thereafter and especially at times when wedding, birthday and anniversary gifts are being selected.

L. J. Wilhoite, Contract Agent of the Chattanooga Railway and Light Company, Outlines Celebration of Edison Day at Chattanooga, Tenn.

The general arrangements for the celebration of Edison Day on October 21st by central stations and electrical dealers throughout the country, were outlined in the October issue of *Electrical Engineering*. At this time several companies in the South took advantage of all opportunity of making Edison Day a "gala time" and displaying not only lamps and lighting progress but all lines of electric appliances. At Chattanooga a novel scheme was devised by Mr. Wilhoite whereby he created a very favorable impression with the public through a moving display and demonstration shown in the accompanying illustrations.

The daily press of Chattanooga cooperated in the promotion of the celebration through publishing hundreds of inches of news matter on the plans and the achievements of Thomas A. Edison. Incidentally the press secured considerable additional display advertising for several days preceeding October 21 as all the business interests in Chattanooga seemed to appreciate the special interest that the celebration movement was creating. As to how the movement was viewed by the press, we quote the following from an editorial in the Chattanooga Times of October 19th:

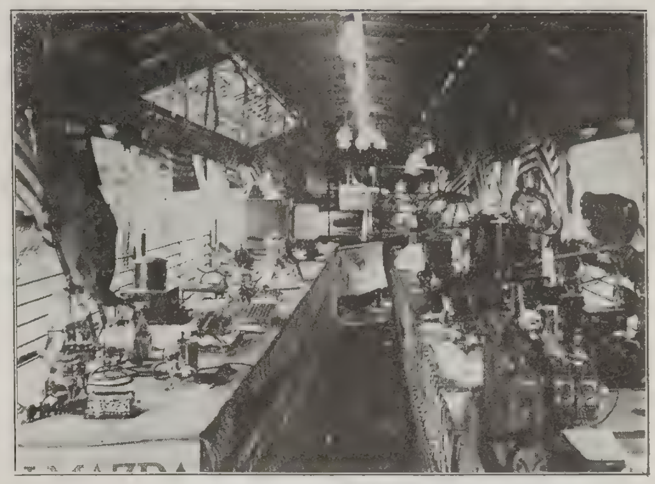


Fig. 2. Arrangement of Apparatus Displayed on Trailers During Chattanooga Edison Day. Celebration.

"The enthusiasm of the local electrical engineers and dealers in electrical supplies exhibited in Sunday's Chattanooga Times over the approaching celebration of 'Edison day,' October 21, ought to have a vitalizing effect on everybody in this community. The occasion will be devoted to showing the marvelous advance in knowledge of and how to use electricity since Mr. Edison, the greatest inventor of them all, first proclaimed electric lighting thirty-five years ago. The local electrical people have become thoroughly inspired with the possibilities of this great agency and they are starting a crusade to make Chattanooga a real dynamo in fact, as it is in possibilities afforded by the two greatest electricity-producing agencies in the country, both of which are right at our doors.

"The celebration on Wednesday will be made memorable in this city, all of the agencies and dealers cooperating fully to make it an event of importance to the community. The display will fully and in detail exhibit all the uses to which electricity may be applied, with especial reference to the lighting and domestic features in which the greatest progress has been made.

"The prevailing note of the dealers in all their announcements is "optimism," and all Chattanooga needs now to keep in the lead is to imbibe that spirit. 'Optimism, courage and eternally at it,' is the motto for this emergency."

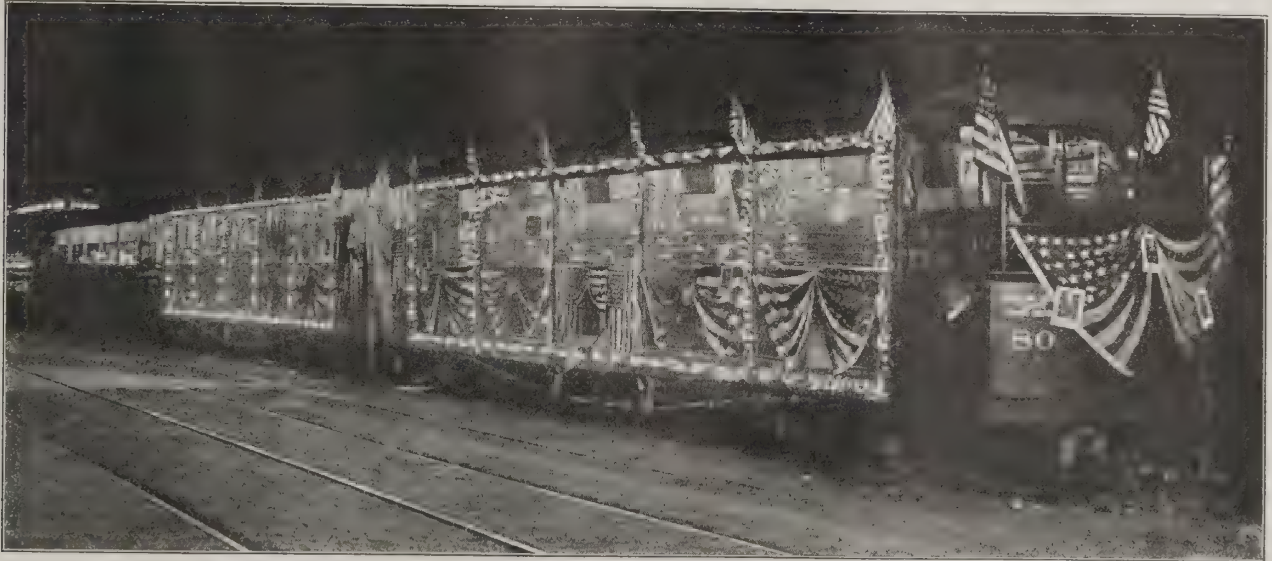


Fig. 1. The Electrical Exhibit on Wheels Held at Chattanooga on Edison Day.

FIG. 3. ANOTHER DISPLAY ON TRAILER OF CHATTANOOGA CELEBRATION.

In regard to conducting the celebration and the details of the arrangements, Mr. Wilhoite has the following to say:

"The celebration of Edison Day in Chattanooga was given by the local Jovian League with the support of the Chattanooga Railway and Light Company and the cooperation of all the electrical dealers in the city. The idea of elaborating upon the original plan of the General Electric Company for boosting the sale of Mazda lamps was suggested at the regular Wednesday luncheon of the Jovian League, just one week previous to October 21, the day set for a general celebration through the United States. When the writer suggested the matter to the League at this time, the response was remarkable. Every dealer in the city became enthusiastic and as a consequence we were able to get together in seven days a very creditable electrical show on wheels. To carry out the plans to arrange the display on wheels instead of in some store room, the seats from three large street car trailers were removed and the exhibits arranged as shown in the accompanying illustrations.

Two of the trailers were used for the display of electrical devices of all kinds with particular reference to those things that should appeal to the Christmas shopper. The third trailer was equipped as a dining room. The city commissioners, together with other prominent local officials were invited to a noon-day lunch and enjoyed a completely electrically cooked menu. This lunch was served by the wives and friends of local Jovians.

"The recognition given the celebration and 'things electrical' by the daily press was ample proof of the success of the affair and the impression it created. Every dealer and all others interested in the celebration are enthusiastic in claiming it one of the most successful attempts to give publicity to 'things electrical' made in Chattanooga and we are 'chesty' enough to claim honors for having successfully carried out in a very short space of time, one of the best Edison Day celebrations held in the United States. One of the most remarkable features of the whole affair was its very low cost when compared with the actual results secured."

New Business Efforts at Pueblo, Colo., More Productive in Nine Months of 1914 Than for 12 Months of 1913.

During the first nine months of 1914 the Pueblo, Colorado, division of the Arkansas Valley Railway Light & Power Company, shows an increase of 964 kilowatts in connected load, this gain being made up of 617 horsepower in motors and 502 kilowatts lighting load. This compares with a net gain of 660 horsepower and 501 kilowatts lighting load for the entire year of 1913. A net gain of 404 customers has been made in the first nine months of 1914 while in the 12 months of 1913 the net gain in customers was 330. These figures are for the Pueblo division of the company only. L. F. Stone, superintendent, says: "The Mountain and Arkansas Valley Divisions have also shown approximately the same increases to date as in the entire year of 1913."

One piece of business recently closed by the company in the mountain division was a contract with the Altman Water Company, Cripple Creek for 125 horsepower to be used in pumping. The equipment will run day and night.

Superintendent Stone has been active in assisting with the promotion of extensions of the city's "white way" lighting system, and recently local improvement clubs, through the cooperation of property owners, were able to finance the "white way" lighting of three additional districts, leaving but one district in the business section not so lighted. The property owners in the streets affected paid for the installation and the city pays for the current, the new system displacing the old arc lighting at a slightly increased cost.

Street Car Advertising Cards Designed by Society for Electrical Development.

In the accompanying illustration six street-car advertising cards are shown that are being furnished members of the Society for Electrical Development, at a very reasonable rate. While the cards were designed for street car use they may be used for window, wall or for other display purposes. Space has been provided for pasting a printed imprint of the user or his telephone number, the society suggesting that this may be done by the user and thus make the combined cost of the card much less than when printing the cards to order. The set of six cards can be secured from the society by its members at a cost of forty cents.

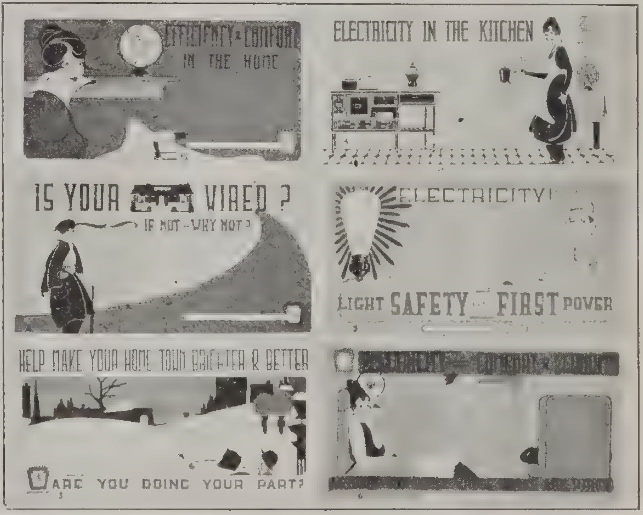


FIG. 1. STREET CAR CARDS FURNISHED BY THE SOCIETY FOR ELECTRICAL DEVELOPMENT.

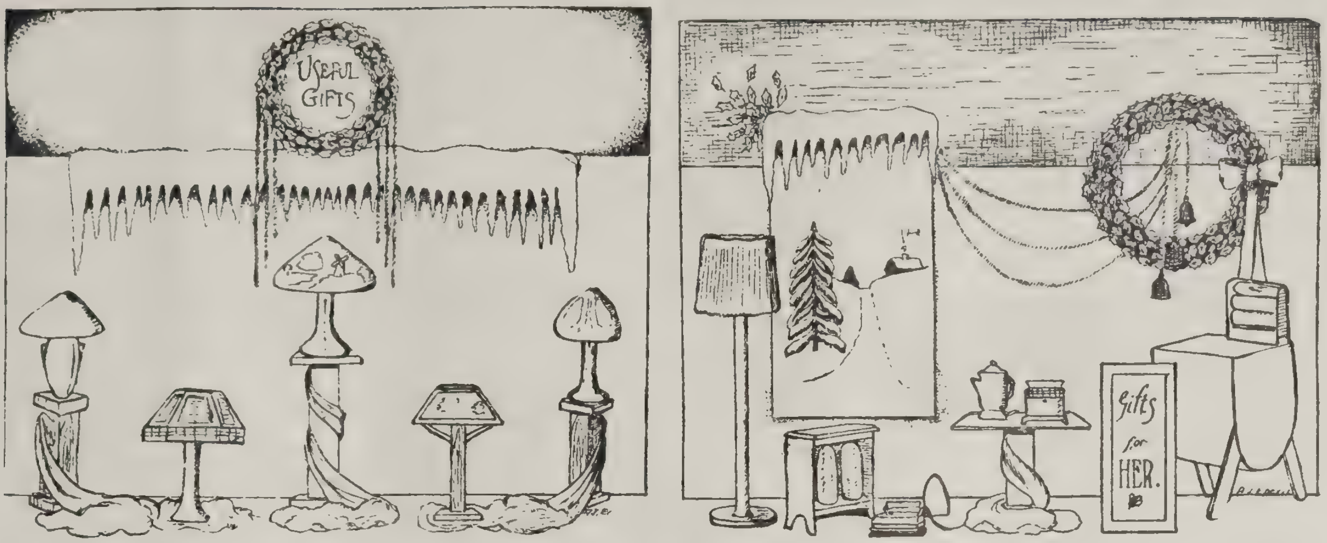


FIG. 2. WINDOW DISPLAY SUGGESTIONS BY THE SOCIETY FOR ELECTRICAL DEVELOPMENT.

The society is also offering suggestions to electrical dealers that aim to enable them to secure a larger share of the possible Christmas electrical appliance business. In Fig. 2, suggestions for special window displays are shown and expert advice can be secured as well as materials for arranging windows of this sort by addressing the office of the society at 29 West 39th Street, New York City.

Uses for Electric Fans in Winter.

The folowing item contains a pertinent suggestion for electrical dealers and central station new business managers:

"One day last winter, as I was walking through the snow covered main street, with my coat collar buttoned up high for protection against the icy wind, my eye chanced to fall on a particular show window I was passing. The window attracted my eye because it was the only one nearby that was not almost entirely covered by frost. It was the only window in sight in which the goods on display could be seen.

"The first thing I saw in the window was a muffler of woven silk and wool, reminding me of my own unprotected neck. The suggestion was timely and I stopped in and bought the muffler, taking the occasion to buy some collars and an attractive necktie that caught my fancy.

"'Your window is the only one I have been able to see into today," I said to the clerk who waited on me.

"'Yes,' he replied, 'we have had no trouble with frost since we put our fan in the window.'

"'A fan, with the temperature below zero!' I exclaimed. 'Oh, yes,' said the clerk, smiling; 'you see the fan keeps the air in motion and so prevents frost which can only condense in a still atmosphere.'

"The idea of using fans in winter interested me and upon investigating the subject I found some very excellent winter uses for fans that I had never dreamed of. In the first place I found that fans are frequently used as Christmas gifts, the donor looking ahead to the discomforts of the coming summer.

"Fans are used in the home in the winter to augment the draft in hot air furnaces. On days when the wind seems 'against the fire' try putting your fan in front of the lower draft of the furnace so as to direct a current of air into the fire pot. The operation of a register can also be improved by setting a fan in front of it with the back to the register, blowing out into the room. Circulation of the warm air is increased and additional impetus given the amount coming up the pipe from the furnace. The same plan can be used to gain greater circulation of the heat from a steam or hot-water radiator.

"Perhaps the most common use of the fan is for purposes of ventilation. An exhaust fan set in the wall of a building and venting out-of-doors will keep the air fresh and pure without creating a dangerous draft. The most congested school-room, factory, office, theater or assembly hall can be kept healthful by such a device.

"Such winter uses for a summer-time device makes the electric fan an all-the-year-round utility."

N. E. L. A. Gifts That Please Booklet.

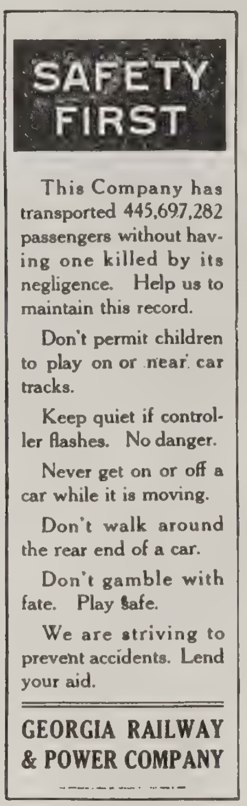
The commercial section of the National Electric Light Association has produced a very attractive 16-page booklet 3½ x 16½ inches with suitable mailing envelope, designed to promote the sale of Christmas heating device business. It is proposed by the commercial section that a large number of these booklets be printed so that attractive production rates can be secured and thus enable the section to supply them at a cost within the reach of the smallest station. The prices set are $15 per 1,000; $8.50 per 500, and $6.00 per $2.50. To produce the booklet in a 1,000 copy edition would on account of the art work and illustrative work it contains, entail a cost of not less than $150. By co-operative ordering of these booklets therefore, an opportunity is offered to secure high class Christmas circularizing material at a very low cost. The price mentioned includes imprinting of the name and address of the central station.

The booklet deals in an attractive manner with the various electrical appliances which make suitable Christmas presents. It is prepared for and will appeal particularly to the housewife. It brings out the modern idea of giving presents which have a utilitarian as well as an artistic value. The booklet is designed to be enclosed with the monthly statements of the central station, as well as distributed over the counter to people coming into the office to pay electric light bills. It may also be distributed from the various electrical stores.

Further information concerning the booklet can be secured and orders filled through Mr. N. H. Boynton, sales manager, publication committee, commercial section, N. E. L. A., Box 387, Cleveland, Ohio.

Safety First Methods Used by Georgia Railway and Power Company.

In line with the "safety-first" campaigns being conducted throughout the country by public utility companies, the Georgia Railway and Power Company of Atlanta, Ga., has installed the accompanying sign printed on celluloid 2 x 6 inches just above the signal button of all its street cars. The message of this sign should appeal to every one who rides the street car and materially reduce avoidable accidents by calling attention to certain precautions. Failure to observe these simple rules has been found responsible for a large percentage of all accidents, a matter over which the company has little direct control without the cooperation of the traveling public.



SAFETY FIRST

This Company has transported 445,697,282 passengers without having one killed by its negligence. Help us to maintain this record.

Don't permit children to play on or near car tracks.

Keep quiet if controller flashes. No danger.

Never get on or off a car while it is moving.

Don't walk around the rear end of a car.

Don't gamble with fate. Play safe.

We are striving to prevent accidents. Lend your aid.

GEORGIA RAILWAY & POWER COMPANY

Safety First Sign Used in Atlanta.

An Electric Club Organized at Athens, Ga.

The organization of The Electric Club at Athens, Ga., has been the result of interest created in electrical affairs by Mr. A. H. Sikes, sales manager of the Athens Railway and Electric Company and starting from general lectures on electrical subjects held something over a year ago. The club which already has a membership of thirty, plans to devote one meeting per month to a discussion of some electrical topic. An electrical expert will be secured to deliver a lecture on this topic.

The first meeting of the club was held October 30, when Mr. T. T. Barnett, of the Bryan-Marsh Lamp Works, of the General Electric gave a talk on, "Store and Mill Illumination," A luncheon was served and will be a feature of the meetings in the future. The next meeting is scheduled for an early date when Mr. E. A. Thornwell an electrical engineer with the Westinghouse Electric and Mfg. Co., of Atlanta, will deliver a lecture on "Southern Water Powers."

The membership of the club is made up of employees of the Athens Railway and Electric Co., electrical contractors of Athens and professors of the University of Georgia. The officers are as follows: President, C. D. Flanigan, vice-president Athens Railway and Electric Co.; vice-president, C. L. Proctor, superintendent Athens Railway and Electric Co.; secretary, Prof. U. H. Davenport, University of Georgia; treasurer, O. M. Roberts, and chairman committee on papers, Mr. A. H. Sikes, sales manager Athens Railway and Electric Co.

Meeting of Electrical Supply Jobbers Association at Birmingham, Ala.

The next meeting of the Electrical Supply Jobbers Association is to be held at Birmingham, Alabama, December 8 to 10. Headquarters will be at the Hotel Tutwiler. This is the first meeting of the association to be held in the South and about 250 jobbers, manufacturers, and their representatives are expected to attend. Mr. Oscar C. Turner, president of the Turner Electric Supply Company, of Birmingham, is in charge of arrangements and reports a carefully prepared program.

Besides a three day program of business sessions, special entertainment arrangements include an automobile tour of the city, a tea for the ladies at the Southern Club, a theater party for the ladies at the Lyric, a cabaret and smoker for the men at the Newspaper Club, a reception and dance at the Country Club, a golf tournament and barbecue at the Roebuck Springs Club, a tennis tournament at the Country club and a tour of the industrial district of Birmingham by special train, a courtesy of the Tennessee Coal, Iron and Railroad Company.

New Business Among Byllesby Properties.

All Byllesby electric properties reporting for the week ending October 30th showed not connected lead gains of 647 customers with 502 kilowatts lighting lead and 2,011 horsepower in motors. If the new power business 1,500 horsepower is for the United Gas & Electric Company, Jeffersonville, Indiana, purchased from the Louisville Gas & Electric Company on a long time contract. New business contracted for included 1,146 customers with 693 kilowatts lighting lead and 295 horsepower in meters. Output of the properties for the week was 8,244,828 kilowatt hours, an increase of 10.6 per cent over corresponding week of 1913. Manufactured gas output for the week gained 4.4 per cent. For the ten months ending October 31, the net gain was 7% over business of 1913.

The commercial department of the Louisville Gas & Electric Company during the week ended October 30th secured contracts for 179 electric customers with 148 kilowatts lighting load and 67 horsepower in motors, and took orders for 331 domestic gas heating installations. Cooler weather caused a marked increase in the sales of natural gas for heating purposes. Completion of a line installed by the purchaser to serve 1500 horsepower electrical requirements of the United Gas and Electric Company at Jeffersonville, Indiana, represent one of the largest single pieces of business added within recent months. The arrangments will save the purchaser a considerable investment in additional power plant capacity.

The board of directors of the Mobile Electric Company, Mobile, Alabama, has declared the regular quarterly dividend of one and three-quarters per cent upon the preferred stock of the company, and paid November 16th to stockholders of record October 31st, 1914.

Installation, Operation and Maintenance

This section is devoted to practical suggestions, experience and data, and is open to all readers who have something to say on every day work and trouble in the plant or sub-station, on the line, in the factory, mill or elsewhere.

Design of 22,000 Volt Feeder Lines for Serving Small Loads.

The construction department of the Georgia Railway & Power Company has recently built an entirely new and original type of 22,000 volt, three-phase, feeder lines for serving comparatively small loads to customers a few miles away from the main 22,000 volt transmission line. These lines are designed by T. F. Johnson, Jr., superintendent of transmission, and the writer, and erected at a low cost per mile. The conductors are strung on 40 foot chestnut poles set an average distance of from 500 to 600 feet apart, and in cases where the profile of the ground permits, even longer spans are used. Strain type anchor poles of extra heavy strength are placed on all line corners and at half mile intervals on straight runs. This anchor construction consists of a series of strain insulators fastened to the body of the pole with ⅝ inch galvanized eye bolts, and a specially designed 4-bolt cable clamp fastens the conductors to the insulators in a vertical plane. This construction is shown in Fig. 1.

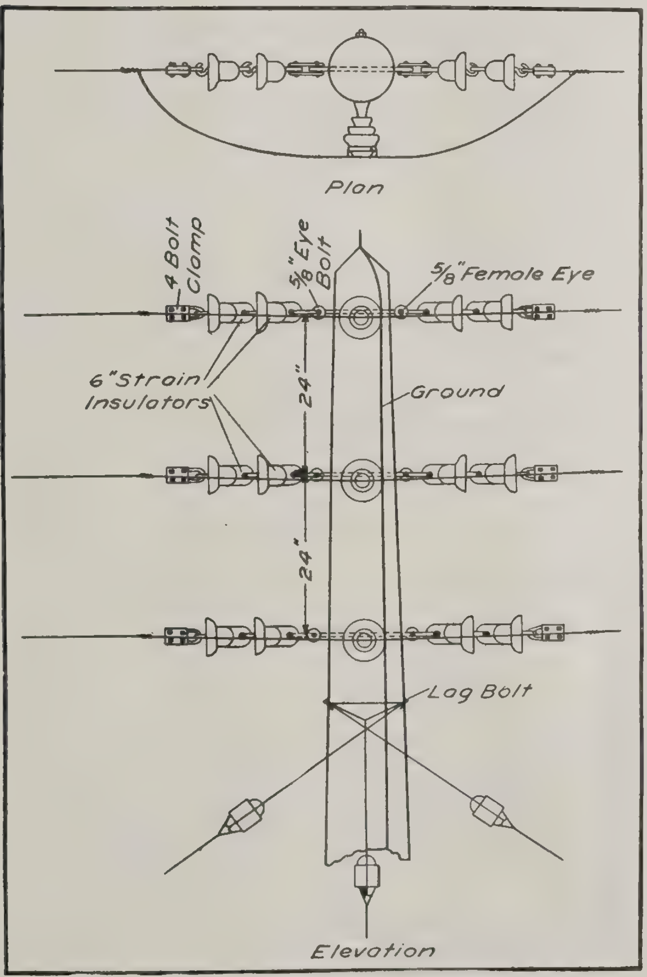


Fig. 1. Details of Anchor Construction.

The poles are storm guyed and set six feet in the ground with a heavy layer of rock, well tamped in for footings. Each pole is treated with a double coating of Carbolineum Avenarius preservative two feet above and below the ground line, and at roof and gaines, and has a quarter inch copper clad strand stapled to the pole before it is erected. One end of this cable is attached to the bottom of the pole in a complete closed circle to insure a good ground, and the other end extends to the tip of the pole to prevent lightning from splitting the pole. No other overhead ground line is used. All hardware and attachments are galvanized. A cross arm of 5/16 inches angle iron is used on all except the anchor poles, with pin type insulators mounted on steel "Lee" pins supporting the conductors between the anchor poles. These cross arms are placed directly at the base of pole roof, and are six feet six inches long, allowing 36 inch spacing between conductors. The middle conductor passes directly over the top of the pole, thereby equalizing the stresses as shown in Fig. 2. The braces are 40 feet by 1½ feet by ⅜ inches attached to arms with one-half inch machine bolts and to the pole with standard lag bolts. The conductors are No. 4 copper clad steel wire of 30 per cent conductivity, with a breaking stress of 2,600 pounds, and weighing only 610 pounds per mile, and are strung with the proper sag estimated to withstand maximum sleet and wind loadings.

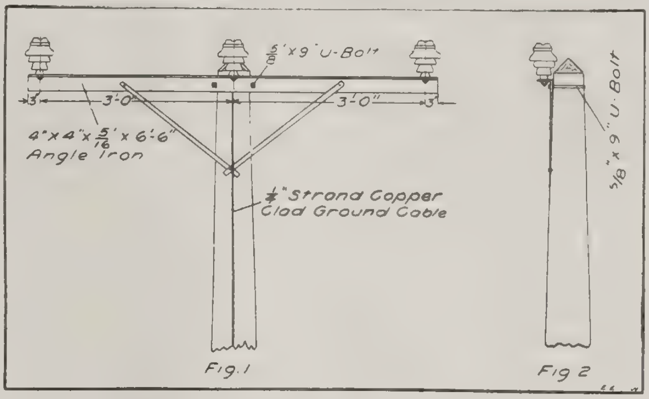

⅝"x9" U-Bolt
3"
3'-0"
3'-0"
3"
4"x4"x5/16"x6'-6" Angle Iron
¼" Strand Copper Clad Ground Cable
Fig. 1
⅝"x9" U-Bolt
Fig 2

Fig. 2. Cross Arm Arrangement.

One span of special interest is 950 feet long, over a valley, and was made possible by placing the poles on two

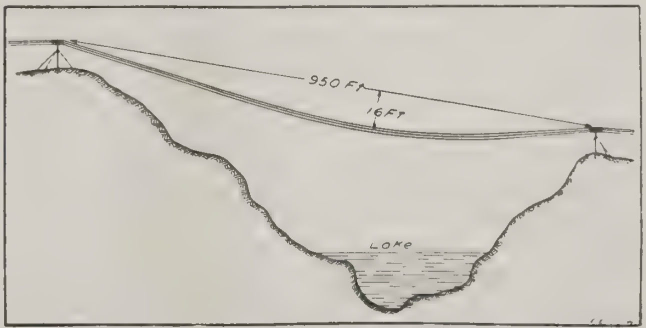


Fig. 3. Construction for a Long Span.

high ridges to allow the required sag of 61 feet. These poles are double storm guyed, with 5/16 inch galvanized guy strand, and 8 inch guy anchors heavily rocked six feet deep in the ground. This is the longest known span on wooden pole power lines.

The first of these lines was completed several months ago, and has given perfect service to date. It is 4.6 miles in length, and fifty-six poles were used, several extra poles being necessary on account of a river crossing, and two special railroad and telephone crossings. The feeder lines are energized by connecting to the main line with Johnson transmission clamps, the connection being made "hot" without interruption of the service.

E. B. Hook, Jr., Supt. of Construction,
Georgia Railway & Power Co.

Bright vs. Dark Lamps for Synchronizing.

When lamps alone are to be used for synchronizing, the question immediately rises as to whether they shall be so connected as to burn brightly, or to be dark at time of synchronism. From many standpoints the advantage lies with the bright lamp, for in no way is there an advantage in favor of the dark lamp. A burned out lamp, a broken wire, or a blown primary fuse, would cause the dark lamp method to indicate synchronism when the machines might be varying greatly in speed, and be completely out of step. A careful engineer would not be ordinarily misled by this however, as the lamps would flicker during the process of bringing the incoming machine to speed, yet an absence of the lighting of the lamps at this time would clearly indicate trouble. But if any one of these things would happen at a time when the machines were nearing synchronism, it would be only natural to assume that they were in step.

The main advantage of the bright lamp method is the indication of the exact time of synchronism more accurately than by the dark lamp method. Tests made by the writer, on an 8 candlepower 118 volt carbon lamp such as is commonly used for synchronizing, showed the following interesting figures bearing on this point: With the lamp burning at rated voltage, a drop in voltage at the lamp terminals, of 7 volts, caused a dimming of the light sufficient to be very readily distinguished. The same lamp required 26 volts at the terminals before a reddening of the filament could be distinguished in a completely darkened room. In a room moderately light by tungsten lamps, 35 volts were required to heat the filament sufficient to see that it was turning red.

Assume a case where two machines equipped with 20 to 1 potential transformers are to be synchronized, with 118 volts carried on the volt meter, which would correspond to a primary voltage of 2,360. In the smaller plants for economy, the potential transformers are ordinarily used for synchronizing, and the lights kept switched off when not actually in use. By the bright lamp method, with a drop of 7 volts on the synchronizing lamps, the machines could be switched together with an instantaneous potential difference not exceeding 7 x 20 (ratio of pot. transf.) equal to 140 volts on the primary circuit, corresponding to a phase displacement of about 21 degrees. By starting to throw the switch just before the lamps get full bright, it will close at the exact instant of synchronism.

Now consider the same case with the machines to be synchronized by the dark lamp method. The lamps would indicate synchronism anywhere from the exact point, to an instantaneous primary potential difference of 35 x 20 equals 700 volts, or 106 degrees out of phase, five times that of the bright lamp method.

The synchroscope, which on account of its cost is generally found only in the larger plants, is the ideal method of synchronizing. It shows accurately the exact moment of synchronism, and whether the incoming machine is running too fast or too slow.

Chas. E. Beckwith.

A Simple Support for Crane Contact Wires.

A great many different arrangements, more or less complicated, have been proposed for supporting the contact wires installed along the runways for supplying the the current to traveling electric cranes. These wires are usually supported along the side of the runway a foot or two below the crane rail, and are so located that the collector shoes or hooks mounted on the crane engage with the wires and thereby convey the electricity to the crane motors.

At each end of each contact wire a strain insulator is provided. Into the loop at one end of the strain insulator the contact wire is made up. The loop at the other end of the strain insulator is bolted into the clevice of a turn buckle or of a tightening bolt by means of which the tension in the contact wire can be adjusted. Such devices at the ends of the contact wires are called the termination supports. At points possibly 15 or 20 feet apart along the crane runway, intermediate supports should be provided to prevent the contact wires from sagging excessively. Figs. 1 and 2 show how such intermediate supports can be very simply and cheaply arranged.

In Fig. 2, a cross section shows a support of the type to be described. To insulate and carry the contact wires, porcelain insulators of the dimensions shown in Fig. 1 are used. While insulators of these dimensions are not always carried in stock by the smaller electrical supply houses, they are regularly manufactured and can be readily procured. Where the runway is of wood, (Fig. 2), each insulator is held thereto with a 3/8 inch lag screw which

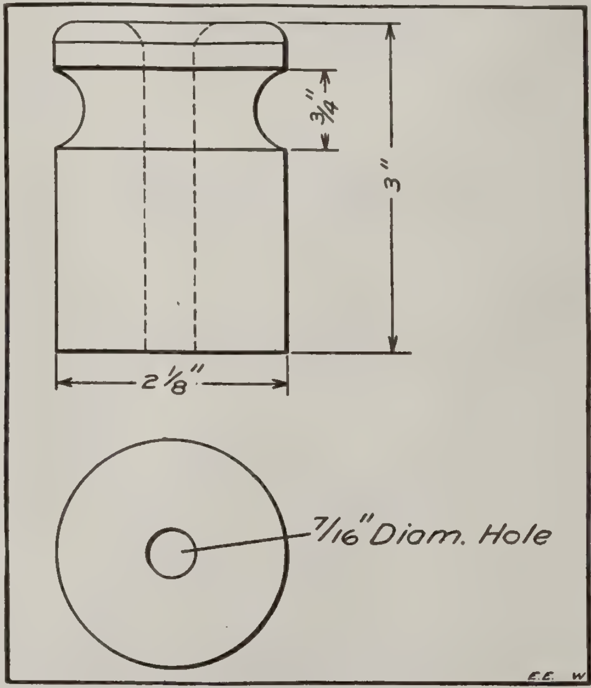


Fig. 1. Dimensions of Insulator.

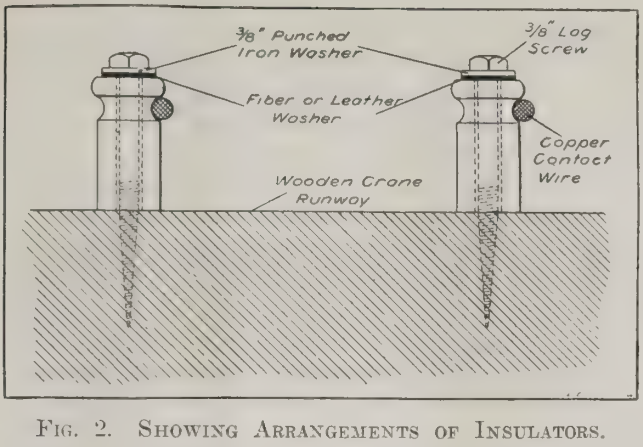


Fig. 2. Showing Arrangements of Insulators.

should be at least 6 inches long. Before the lag screw is turned into the wooden runway, a hole should be bored with a 3/16 inch bit for its reception. Between the head of the lag screw and the top of the insulator, a leather or a fiber washer should be placed to prevent cracking of the porcelain, and a 3/8 inch punched iron washer should be used just under the head of the screw to prevent the corners of its square top from digging into the soft leather or fiber washer.

Where the runway is of steel, machine screws can be used instead of lag screws for supporting the insulators. Ordinarily the web of the runway girder will be thick enough to provide a sufficient number of threads for a substantial attachment. If the web is not thick enough, the intermediate supports can be either located at stiffener plates where an adequate thickness of metal is available, or the insulators can be held to the web with machine bolts, the nuts of the bolts being located on the unexposed side of the web. Where the insulators are attached directly to the steel plate, as just described, a washer should be used as shown in Fig. 2; and in addition, a leather or fiber washer should be inserted between the base of each insulator and the steel.

If the porcelain insulators clamped directly against the face of the crane runway, as shown in Fig. 2, do not locate the contact wires in the correct position, the contact wire locations are usually specified by the crane manufacturers and are shown on the construction drawings sent out by them. Spacing blocks of wood or metal, or a yoke forged from bar iron can be inserted between the bases of the insulators and the runway girder to increase the distance between the contact wire and the face of the girder. The normal position of the contact wire is, as shown in Fig. 2, in the groove of the insulator.

George F. Miles.

What Is the Function of Lightning Rods?

Mr. E. W. Hall's question in your October issue and the discussions in the November number are of considerable interest, not only as regards details of actual practice but because they bring up a number of points concerning some of which our experience and our theoretical knowledge are still somewhat limited, so that there is ample room for differences of opinion.

As regards the practical question, there appears to be no doubt as to the advisability of installing lightning conductors upon barns and isolated buildings generally, and especially when such buildings occupy exposed positions in localities known to be subject to lightning strokes. The mass of evidence presented from time to time, much of which has necessarily been of a negative rather than of a positive kind, seems to indicate conclusively that there is a very appreciable amount of protection afforded against lightning by installing a well-designed and generous system of lightning rods. On the other hand, in some cases the expected protection has been found either insufficient or entirely lacking, so that the general efficacy of lightning conductors upon buildings is still seriously questioned in some quarters.

Without going into discussion of designs for lightning-rod systems, it is only necessary to point out that, in order to be even reasonably effective, any system must be properly designed to suit the building upon which it is to be placed, and all conductors must be of sufficient cross-section and carefully installed and well grounded. Probably no ordinary simple system is absolutely protective, but much can be done to protect barns and other buildings by installing a number of conductor points located at best positions, well above all parts of the building itself, interconnected together in groups by conductors where the configuration of the building will permit, each group of points being properly and thoroughly connected to earth by a main conductor of ample size, run as directly as possible to ground and then adequately grounded. When the design of the building will readily so allow, the several groups of points may, and preferably should, also be well interconnected by branch conductors of ample section, but in any case for a building of even moderate size, there should always be at least two separate and distinct main conductors to ground; and for larger buildings there should be four, six, or more conductors to ground, arranged near the center and the corners or otherwise more or less symmetrically located at different positions around the building.

The old saying that "Lightning never strikes twice in the same spot" is an absolute fallacy as far as any scientific truth is concerned. As a matter of fact, lightning seems very likely to strike again and again near the same same spot, or even at the same identical spot, not necessarily during the same storm but on future occasions, provided the same spot is still there. Lightning invariably takes the easiest path between the points concerned; and, sooner or later, similar causes and similar local conditions are likely to bring a future thunderstorm over almost exactly the same path as taken by some earlier storm.

There is a considerable amount of literature available in regard to lightning and lightning rods, such as Oliver Lodge's work on "Lightning Rods and Lightning Guards," Prang's older book on "Lightning Conductors," and several pamphlets issued by the U. S. Department of Agriculture relative to the installation of lightning rods for barns, etc. A bulletin recently issued by the Agricultural Department of Ontario is said to contain some valuable information on this subject, but I have not yet had opportunity to see it. A lot of interesting and valuable data has been published from time to time by the General Electric Co. and Westinghouse Electric and Mfg. Co. in their various bulletins on "Protection from Lightning," but these for the most part go into the question of protection of electric lines and apparatus rather than buildings. An article on "Lightning Protection of Buildings," by Prof.

Ernst J. Berg, in the January, 1913, number of the General Electric Review, covers some of the points raised in Mr. Hall's question, and also gives some interesting hypothetical figures relative to the possible voltage, frequency and amperage of some lightning discharges.

As to the question, "What is the Function of Lightning Rods," they seem to perform two kinds of service, of generally similar but slightly different natures, according to the conditions of each occasion. Their first function is to afford opportunity for comparatively low tension or small charges of static electricity to discharge easily between the earth and the clouds immediately above, so as to prevent the accumulation of large and dangerous charges of atmospheric electricity in the immediate vicinity. To satisfactorily perform this service, it is necessary that the lightning rods be equipped with sharp points, and be made as high as possible, also that the installation of lightning rods be very general in the city or village concerned, and not confined merely to a few isolated buildings. While the actual evidence along this line is limited, it does appear that in certain places where lightning storms used to be frequent and severe such storms have become more rare and less violent since there has been a very general installation of lightning rods on nearly all of the buildings. Such evidence is necessarily of a somewhat negative order, but there is no good reason for doubting that a general installation of lightning rods in any neighborhood really does have some noticeable effect in "draining off" at least part of the electricity from passing clouds and in thus helping to prevent large local accumulations.

The other function of lightning rods is the more commonly understood one, namely, to afford a safe passage to earth of any sudden lightning discharge which might otherwise pass through the building concerned and cause fire or other damage; and obviously all installations of lightning rods, and especially those for isolated buildings, should be designed with this end in view, although the other possible function of the rods should also be kept in mind. These sudden discharges are generally so-called secondary discharges, caused by the redistribution of electric charges in the clouds, as portions of these clouds or other adjacent clouds discharge between themselves, or between the clouds and the earth, at some other places not very far distant. These sudden secondary discharges differ from the leakage or drainage discharges referred to above, in that for these sudden discharges there is no particular advantage in using pointed rods, as balls or knobs of the same height will be struck just as readily. Points should be used generally, however, as they will serve either purpose; but when protection is desired merely for separate isolated buildings, and not for an extensive group, there is no advantage in carrying the points up higher than a few feet above the exposed parts of the building, as in such case it is desired not to invite discharges but only to take them safely to earth, if they do come.

In spite of all that is now known of the effects of lightning, and of means for taking lightning discharges to ground, through predetermined and safe paths, so as to relieve buildings and electric circuits and apparatus from danger from such discharges, comparatively little seems yet to be known concerning the ultimate causes of lightning, or the reasons for its selecting the particular points where it strikes. In many cases the highest buildings and trees appear to be safely passed over, while other somewhat less conspicuous points are struck. In such cases, however, the points actually struck must be unquestionably the most conspicuous electrical conductors in the path of the clouds concerned, after these have accumulated the necessary amount of charge required to break down the resistance of the intervening air; and such striking points will frequently be found to be upon the first noticeably rising ground after the storm clouds have passed over a comparatively lower area, such as the low-lying part of a town or a river valley or flats. In such cases of violent lightning strokes, frequently the redistribution of charge is simultaneously effected by other flashes between the clouds concerned and adjacent clouds, and also flashes between these latter clouds and the earth at some more exposed point on the next or some more distant hill or rising ground.

Lighting is known to be merely so-called static electricity, which becomes charged in certain clouds under certain conditions, which clouds then form one member of a huge condenser, or a series of condensers, while the earth below or other adjacent clouds form the other members, and which finally discharges by sparking to earth—or to the adjacent clouds, or to both—when the electro-static strain is sufficient to break down the resistance or dielectric strength of the intervening air; but just how, and under what precise conditions, the clouds become so charged, does not seem to be yet thoroughly understood.

Referring now to the statement in the lightning-rod advertisement, quoted by Mr. Hall, there appears to be no justification for such statement. As far as seems to be known, there is no noticeable charge of static electricity generated locally upon an accumulation of hay, etc., when stored in a barn, either by wind "blowing through it" or other cause, and which could possibly start a lightning discharge. On the other hand, when the hay is so stored, it appears to spontaneously generate considerable internal heat, which causes a gradual rising of heated air and vapor from the mass. The heated air liberates some moisture as it rises through the cooler upper layers, and the results are then such as to take away most of the dielectric or insulating qualities of the hay, etc., and to dissipate any small electro-static charges which it might have accumulated, and to make the mass of hay or other fodder a semi-conductor of electricity, though still of very high resistance. At such stage the hay or other material is then usually a somewhat better electrical conductor than the building in which it is contained; and, when the building is struck by lightning, a sufficient portion of the discharge frequently passes through the mass of hay, etc, and sets it on fire because of the heat generated partly by the electric current being forced through such a path of high and imperfectly connected resistance, and partly by the heat evolved directly at the points where the discharge enters and leaves the hay, etc., and at any other breaks and air spaces in its passage through the hay, etc., or through the barn itself. When out in the open, and especially during dry, cold weather, probably some static charge is very frequently if not always generated by wind blowing against hay, trees, etc.; but, when any of such charge is stored by nature for future use (and under suitable atmospheric conditions, probably a considerable part of such charge is so stored—at least temporarily) it is by means of passing clouds and self-contained bodies of air and vapor, and not directly in the hay, trees, etc., all of which will very shortly transfer the bulk of their share of the developed charges back to earth and it seems more than likely that the charged clouds and bodies of air and vapor may frequently retain their accumulated charges for very long periods, and may be blown away to very great distances, before they eventually meet conditions and combinations of other charges which cause them to be finally discharged.

In the same advertisement, the statement regarding the development of static electricity on cloths and other insulating materials in mills, etc., and by belts under certain conditions, is true in a general way, but this has no direct bearing upon lightning storms, except that—as Franklin long ago demonstrated—such static electricity is similar to that developed directly by nature, and it differs from lightning only in regard to the quantity of energy stored and liberated at one time and not at all in quality.

As regards static electricity from belts, it may be incidentally of interest to point out that much less electricity is generated or exhibited by belts when they are so heavily loaded as to perceptibly slip upon their pulleys than by the same belts when running at lighter loads and practically without slipping. A small amount of electricity may sometimes be developed in a belt, when of considerable length between pulleys, by friction caused by its running rapidly through the air, and also by its beating the air when it runs unsteadily; but by far the greater portion of the charge is generated at the points where the belt leaves the pulleys, and is apparently caused in part by the sudden cleavage action where the belt actually leaves the pulley face, and in part by the readjustment of the surface tensions and internal strains in the belt itself, just before and immediately after it leaves the curved surface of the pulley and begins to take up a comparatively straight course and a relaxed condition where it leaves the driving pulley and an increased tension where it leaves the driven pulley.

V. C. Wynne, Consulting Engineer.

Comparison of Condensing Operation in Small Capacity Plants With Non-Condensing.

It is frequently required to determine whether it is advisable to run small units condensing or non-condensing. When we speak of small units, those of four to five hundred horsepower, such as is commonly used in cotton mills and medium sized light plants are meant. It is generally conceded that where an engine of this size is not overloaded, it is best or rather more economical to operate it non-condensing, however if the unit should be overloaded then the condensing apparatus would be of advantage. Since this is the general idea of this problem, we will discuss in what follows a special case to find out which type should be selected for a certain service.

In the selection it is necessary to decide on some type of engine and whether it will be simple or compounded. Since the case that the writer has in mind and will give data for is a compound Corliss type engine, and since this type is very popular in the cotton mills of the South, we will select this type for our example. For convenience we will use an engine that will develop 500 horsepower, and as our argument will require more data than this, we will have to assume the other conditions that are usual in such arguments. We know that this same engine will develop more power running condensing than non-condensing, or it will develop the same power on less steam, and it is this last case that we will be interested in. We will assume that 500 horsepower is all that is required by the mill and find the most economical way to get this power required.

In the engine proper of the condensing arrangement the steam consumption will be much lower than in the other type, but we must charge against the condensing engine the steam that is used in running the condenser. This machine may be driven direct by steam or it may be run from the shaft of the engine or by an electric motor taking current (direct or indirect) from the engine generator. Our plant has available a condensing water pond say one-half million gallon capacity, with a means of replenishing this to the amount of the evaporation required in the operation of the plant. The condenser is of the steam driven type for two reasons: First sufficient steam is not available to heat the feed water unless this type machine is used and next, this is the most economical machine that we can select, unless we credit heating the feed water to it. It thus shows up greatest charges from condensing. We will also have to charge against this type of apparatus some means of cooling the condenser water, as this will be one of the operating expenses that will exist in the condensing over the non-condensing plant.

At this point we may decide just what means of cooling to use. Two ways are available namely, the cooling tower and the spray nozzle system. The first type requires the water to be pumped over the top of same, which is never less than 25 feet and usually 35 feet high, so that this head must be worked against in pumping the water over the tower. In the second or the spray nozzle system, this head or pressure may be reduced more than half, that is the nozzles will operate satisfactorily against 5 pounds pressure, which is only about 11 feet. From this it can be seen that it is much more economical to operate the nozzles than the tower. Another advantage of the nozzle is that the first cost is only about one-half of the cost of the cooling tower.

CONDENSING ENGINE.

This engine will use about 15 to 17 pounds per horsepower, or we will use 16 pounds as an average. Then 500 horsepower × 16 = 8,000 pounds steam per hour.

In the South, the average condensing water will be about 85 to 90 degrees initial temperature, and on this basis we will require about 50 to 1 of water to steam condensed. Then water required is,

$8{,}000 \times .002 = 16$ gallons per minute.

$50 \times 16 = 800$ gallons per minute of water to be handled by the condenser, and to be cooled by the cooling nozzles.

To obtain the amount of work done by the condenser, we will have to know the vacuum and the head that the condenser will have to discharge against. We will assume 26 inches vacuum (30 inches barometer) and 5 pounds pressure at the nozzles, and about one pound for friction in the discharge pipes, making 6 pounds total as the discharge head. Then

$[800 \times 8.33 \times 14.7 - (4 + 6)] \div (33{,}000 \times .433) =$ 5-pump horsepower.

The ordinary type of jet condenser would use about 120 pounds steam per hour, per horsepower, so we charge this amount up against the engine unit.

$5 \times 120 = 600$ pounds steam per hour.

Since we do not have sufficient exhaust steam to heat the feed water, then we will have to debit the condensing outfit with the amount it will be short over the non-condensing outfit as this type would have all the steam necessary for this purpose and still steam to waste.

We will first work out the amount of exhaust steam that we will have from the boiler feed pump, and to this add that we have already found available from the condenser, and see if this amount will heat the feed water to the maximum temperature. We will assume that a boiler pressure of 125 pounds is used and the friction in the water line makes the pump operate against about 140 pounds. We will have to generate enough steam to run the engine, the condenser, and the boiler feed pump, and since we do not know this at present we will have to assume a portion as follows: 8,000 pounds for engine; 600 pounds for condenser; 300 pounds for pump (assumed) or a total of 8,900 pounds of steam to be generated per hour for the plant. Then

$(8{,}900 \times 140) \div (60 \times 33{,}000 \times .433) = 1.5$ pump horsepower per hour.

Since the boiler feed pump is very extravagant in steam consumption, we will assume that this pump will use 120 pounds steam per hour per pump horsepower. Then,

$1.5 \times 120 = 180$ pounds, say 200 pounds per hour.

We have then available for heating the boiler feed water, 800 pounds steam per hour. We also have available in this steam above 212 degrees 966 B.T.U. (latent heat) or a total of $800 \times 966 = 772800$ B.T.U.'s.

We can take the boiler feed water going to the heater from the discharge from the condenser discharge, and in this way get hot water to start with. The temperature of this water is about 110 degrees with a 26 inch vacuum. If we raise the water to its maximum temperature (210 degrees) each pound of water will absorb $210 - 110 = 100$ degrees, and and we have 8,900 pounds to heat, therefore we will require: $8{,}900 \times 100 = 890{,}000$ B.T.U.'s, which is not quite enough to raise the water to a maximum temperature of 210 degrees but it will raise it $772{,}800 \div 8{,}900 = 89$ degrees.

Thus 110 plus 89 gives us a temperature of 199 degrees for the feed water, or about 11 degrees short of what we would get from the non-condensing outfit. This is equivalent to 1 per cent loss in the total coal pile and should be charged against the condensing unit.

NON-CONDENSING ENGINE.

We will now see what the non-condensing unit will require in the way of steam to operate it. Since we have assumed the Corliss type of engine cross compound, we may expect a very good steam economy from this machine although running non-condensing. Therefore under these conditions we may expect about 20 to 22 pounds per I.H.P. per hour. We will use the average of this or 21 pounds per horsepower hour. Then, $500 \times 21 = 10{,}500$ pounds per hour required.

We will use practically the same amount of steam for the pump in putting the water in the boiler as in the preceding case. We will have then to generate, 10,500 pounds for engine; 200 pounds for boiler feed pump or a total of 10,700 pounds per hour. Then $10{,}700 - 8{,}900 = 2{,}800$ pounds per hour more steam required for the non-condensing engine over the condensing type. We will have to capitalize this, and then determine the cost of the condensing outfit with the cooling outfit to see if it will warrant us to install the later type.

We will assume coal delivered at the plant at $3.00 per ton, and an evaporation of 8 pounds of steam (water) per pound of coal in the boilers.

Then, $2{,}800 \div 8 = 350$ pounds coal per hour, and

$(350 \times \$3.00 \times 10 \times 26 \times 12) \div 2{,}000 = \$2{,}238.00$ per year cost of coal over that required for condensing operation.

From this amount we must deduct the first cost, additional operating expenses, interest and depreciation on the condensing equipment, to see if the saving will warrant the additional expense of same. There are several types of the jet condenser, namely, the old steam driven machine that has been used so long for this class of service, and the more modern type of machine, such as the low lift jet condenser with centrifugal water pump and centrifugal air pump. This type of machine is used more on turbine installations where a higher vacuum than we desire is required and the machine is rather expensive so we will not consider it but will figure on the other type. For the service considered, we would require about a 10 x 18 x 18 simplex double acting steam driven condenser, suitable for discharging against the head mentioned in the preceding calculation. This machine would cost about $750 to $800 erected on the foundations. The spray cooling nozzles would cost about $900 to $1,000 installed ready for operation. Since a pond would be required by the insurance company for fire protection, we will not charge this item against the equipment.

We have then as first cost for the condenser installation, the following:

CHARGES AGAINST CONDENSING APPARATUS.

Cost of Condenser	$ 800.00
Cost of Cooling Nozzles	1,000.00
Cost of Pipe Work on Condenser	200.00
Total First Cost	$2,000.00
Interest on investment at 6 per cent	$ 120.00
Depreciation at 6 per cent	120.00
Upkeep, wear and tear at 3 per cent	60.00
Total Fixed Charges	$ 300.00

Since we have a 1 per cent loss in the heating of the feed water in the condensing arrangement, we will add this as a yearly charge to the condenser. Thus 1 per cent of the additional coal cost due to non-condensing is $\$2{,}238 + 0.01 = \$22.38$. Then the total outlay thte first year due to condensing is,

$\$2000 + \$300 + \$22.38 = \$2322.38$

The next year we would have only the interest charges to make against the apparatus or $322.28. From this data it would seem that the saving in coal cost the first year would nearly pay for the apparatus and all charges against it and result in a complete net saving in every year thereafter of,

$\$2{,}238 - \$322.38 = \$1{,}915.62$ per year.

There are a large number of plants in the South, particularly cotton mills that are running non-condensing or on a very low vacuum on account of the fact that sufficient cooling water cannot be obtained for their condenser. With a modern means for cooling water and the low first cost of such apparatus, there is no reason for any plant operating on less than a 26 inch vacuum where they have condensing apparatus installed. This statement holds as well where cooling equipment is not installed if a cooling pond large enough to handle three to five thousand gallons of water is available. A system of spray nozzles used with the condensing outfit will make this higher vacuum possible and bring about better economy in the whole steam using equipment. In those plants where condensing equipments are not in use and the engine capacity as large as outlined in the above consideration, a problem of economy at once suggests itself and is worthy of an investigation.

Earl F. Scott, M. E.

Questions and Answers from Readers

Readers are invited to make liberal use of this department for discussing questions, obtaining information, opinions or experiences from other readers. Discussions and criticisms on answers to questions are solicited. However, editors are not responsible for correctness of statements of opinion or fact in discussions. All published answers and discussions are paid for.

Use of Electric Iron on Controlled Circuits.

Editor Electrical Engineering:

(492) The writer has a house wired for eleven 16-candlepower, 220-volt d. c. lamps, and uses a controller, so that only six lamps can be used at a time. What would take place and how would the controller act if an electric iron consuming 500 watts were used on the circuit?

When a house is wired for lighting according to the code ruling of not more than 660 watts load on a single cutout, is it permissible and safe to use two 500 watt electric irons on the circuit? If not what arrangement must be made to make such possible? Subscriber.

Changes Necessary to Operate 440-Volt Motor on 220 Volts.

Editor Electrical Engineering:

(493) The writer would like to know what changes in the connections of a 3-phase induction motor must be made which is wound for 440 volts, so as to operate it on a 220 volt circuit. Suppose for example, the winding has five coils in series per-phase, per-pole. D. H.

Why Does Commutator Become Black?

Editor Electrical Engineering:

(494) The writer has recently had practically the same trouble as described by C. A. H., in the November, 1914 issue of the *Electrical Engineering,* question 488. What I desire to know is what causes the commutator to become black at three equally spaced spots? Why doesn't the entire commutator become black?

If one of the field coils on a 220 volt, 200 ampere, 6-pole, lap wound, d. c. generator becomes short-circuited what will happen? What would be the result if the armature were wave or series wound? Geo. M.

Features of Overload and No Voltage Release for Motor Starters.

Editor Electrical Engineering:

(495) Please give diagrams that show the arrangement of no voltage and over load release devices on motor starters. Also explain the main reasons for same with different types of motors, A. C. and D. C. Plant Operator.

The Electron Theory of Magnetism.

Editor Electrical Engineering:

(496) Please explain through the columns of *Electrical Engineering* the main details of the Electron Theory. If there is a book or pamphlet on this subject that takes the matter up in a clear way, please refer to same.

W. E. R.

Calculating Steam Consumption of an Engine.

Editor Electrical Engineering:

(497) Please show how to calculate the steam consumption of a simple steam engine exhausting to atmosphere. How would this consumption be effected when working against a back pressure of 4 pounds gauge pressure? G. T. B.

Connections for Changing 2-Wire Generator to 3-Wire.

Editor Electrical Engineering:

Regarding questions 462 and 468 and two answers in August issue, the method used by U. K. S. as well as the answers submitted make use of the Dobrowolsky system of three wire generators invented in 1894. The main objection to its use in this particular instance is that the unbalanced current must pass through one of the transformer coils thereby losing some of the voltage. The best method in use at present is not available for this machine on account of patent rights as it was patented in 1908 by James Burke of Erie, Pa., who sold the patent to a well known concern. U. K. S. claims that the armature in the machine is wound like a rotary converter, that the dynamo has six poles, and yet he only uses two connections to the armature winding. The other answers make use of six connections. Rotary converter armatures are wound either series or parallel drum. With the series winding only one connection is required to each collector ring for any number of poles and as U. K. S. claims successful operation his dynamo is probably wound that way. The dynamo without the transformer is merely a double current generator or a rotary converter driven by external power and from that standpoint U. K. S.'s method is as good as any that can be used. However, it is good practice to make certain that the armature is properly balanced mechanically after attaching the connections and rings.

A. C. vs. D. C. Equipment for a Small Factory. Ans. Ques. No. 470.

Since the load mentioned is constant speed and an increase calling for considerable change is required, it seems that there are quite a number of things in favor of the use of A. C. equipment. The maintenance cost of induction motors is very small compared to D. C. motors if they are properly installed. This is due to the absence of commutators, brushes, brush rigging, etc In the later types of induction motors the troubles formerly experienced due to heating of the end rings and unsoldering of the rotor bars have been practically overcome and although they have a very small air gap the large bearings do not wear fast enough to cause any trouble. The three-phase, three-wire motor is preferable to the single-phase and can be used with only a star delta connection and switch for starting in sizes up to 7.5 horsepower or with only a switch for sizes of 5 horsepower and smaller. Single-phase motors and lighting systems may be readily connected to any two of the three-phase leads but it is advisable to keep the load as nearly balanced as possible. The three-phase, three-wire system is in most cases the best and in changing from D. C. to A. C. the addition of a single wire will in most cases suffice if the old wires are large enough. A voltage of 220 or 440 would probably be advisable. If the higher voltage is used, tungsten lamps of a lower voltage connected in series may be installed. The installation seems rather small to make use of a turbine and the practical economy arising from its use questionable. By referring to the advertising pages of *Electrical Engineering* for October the addresses of parties who can furnish prices and estimates as well as valuable information on A. C. equipment may be found.

Starting Two Motors from One Auto-Starter. Ans. Ques. No. 473.

A 50 horsepower auto-starter is rather large to use on a 15 horsepower motor and if the transformers have any taps they should be placed on the lowest voltage obtainable. It would be better to trade the starter for a 15 horsepower size and start only one motor at a time, in which case starting fuses would not be needed. With the apparatus used, Figure 2 by V. C. Wynne, October issue, seems to be as good as any.

H. H. Van Keuren.

Starting Two Motors from One Auto-Starter. Ans. Ques. No. 473.

Editor Electrical Engineering:

I should like to take issue with the statement of Mr. Sackett on page 469 of the October issue when he says that if a 30 horsepower auto-starter be utilized for starting a 15 horsepower motor, the motor will be burned out. This is not the case.

If a plant be equipped with two 50 Kva transformers for supplying three-phase service and if but a single 5 horsepower motor be operated at a given time from these transformers, the motor will not be injured. This fact is obvious from everyday experience. Now the auto-starter is nothing more than a transformer and a means of switching the transformer in and out of service. The auto-starter provides a reduced voltage for starting the motor or motors connected to it. As an example let us say that a 220 volt auto-starter provides 160 volts for starting service. Let this be a 30 horsepower starter. This starter will then step the feeder voltage down to approximately 160 volts regardless whether a 30 horsepower motor is started from it or one 15 horsepower motor or two 15 horsepower motors. There will be a certain rush of current due to this voltage impressed upon the motors at rest and the duration of the heavy current will depend upon the load to be started. The point to be brought out is that the starting current depends upon the motor characteristics and the load and not upon the size of the auto-starter —but upon the starting voltage which it supplies.

Gordon Fox.

Derivation of Wiring Formula. Ans. Ques. No. 478.

Editor Electrical Engineering:

In question No. 478 of the September issue of *Electrical Engineering* E. F. S. asks for the derivation of the following wiring formula:

$$\text{Cir. mils} = [W\ D\ K] \div [E^2 \times \%\ \text{line ilss}] \text{———} (1)$$

Where (W) is the watts delivered: (D) the distance of transmission in feet; (E) the line voltage at receiver; (% line loss) a percentage of watts delivered, and (K) a constant varying with the power factor and system of distribution used. For the case of a 3-wire, 3-phase system, let (I) be the current in amperes, in one line wire; (R) the resistance in ohms, of one line wire; (cos Θ) the power factor of the receiver circuit; (k) the specific resistance of the line wire in ohms per mil foot. Then we have

$$R = (k\ D) \div (\text{Cir mils}) \text{———} (2)$$

$$I = W \div (\sqrt{3}\ E \cos \Theta) \text{———} (3)$$

$$\text{Watts line loss} = 3\ R\ I^2 \qquad (4)$$

$$\%\ \text{line loss} = (3\ R\ I^2 \times 100) \div W \text{———} (5)$$

Substituting in equation (5) the values of (R) and (I) obtained from equations (2) and (3) gives,

$$\text{Cir. mils} = [W\ D\ K] \div [E^2 \times \%\ \text{line loss}] \qquad (6)$$

$$\text{Where } K = (100\ k) \div (\cos^2 \Theta) \qquad (7)$$

The formula could be similarly derived for a system of any number of phases, but (K) might be different. Thus for a single phase system $K = 200k \div \cos^2 \Theta$; for 4 wire two phase system $K = 100k \div \cos^2 \Theta$; and for a four wire four phase system $K = 50k \div \cos^2 \Theta$.

Let us compare the formula (1) with the formula given by E. F. S.

$$\text{Cir. mils} = (746\ P\ D\ K_1 \times 1.5) \div (n \cos \Theta \times E \times e) \quad (8)$$

Where (P) = horsepower of motor; (n) = efficiency of motor; (e) = volts line drop in the wiring; and the other symbols as before.

The volts drop in a D. C. circuit would be

$$e = [\%\ \text{line loss} \times E] \div 100 \text{———} (9)$$

In an A. C. circuit the drop for the same current will usually be greater than this because of phase displacement by line reactance, so we can write for A. C. circuits

$$e = [\%\ \text{line loss} \div 100] \times E \times (M \div \cos \Theta) \text{———} (10)$$

Where (M) is some factor which may be positive, negative, or zero, but for approximations can be taken near 1.0 for lagging power factors. Solving equation (10) for (% line loss) and substituting its value in equation (6) gives,

$$\text{Cir. mils} = [W\ D\ K\ M] \div (100\ e\ E \cos \Theta) \text{———} (11)$$

$$\text{Now } W = 746\ P \div n, \text{ and } K_1 = K \div 100 \qquad (11)\text{a}$$

Substituting these values in equation (11) gives:

$$\text{Cir mils} = [746\ P\ D\ K_1\ M] \div [n\ e\ E \cos \Theta \text{———} (12)$$

If we let M = 1 and multiply equation (12) by 1.5 to allow for 50 per cent overload, we obtain equation (8) which is the forumla given by the Standard Handbook. Thus comparing formulas (1) and (8) we see that in the first place $K = 100\ K_1$; second formula (8) allows for 50 per cent additional power, as stated in the Handbook; and third, formula (8) also contains a factor (M), which for approximate calculations can be taken equal to 1.0.

The reason why E. F. S. does not obtain the same results from formulas (1) and (8) are: (a). In using the formula (8) he is allowing for 50 per cent more power than formula (1) takes care of. (b). In his calculation he appears to have used 51 ÷ 0.88 for line current, while

55.7 amperes is the correct value. (c). He calculated the per cent line loss incorrectly.

The correct solution by equation (1), allowing for 50 per cent extra power (so we can compare the result with that obtained by formula (8)) is as follows:

$$W = 1.5 \times \sqrt{3^1} \times 220 \times 55.7 \times 0.8 = 25{,}500 \text{ watts}$$

from equation (10),

$$\%\ \text{line loss} = [100\ e \cos \Theta] \div [E \times M] \qquad (3)$$

$$= [100 \times 3 \times 0.8] \div [220 \times 1] = 1.09$$

Substituting these values in formula (1) gives

$$\text{Cir. mils} = [25{,}500 \times 40 \times 1690] \div [(220)^2 \times 1.09 = 32{,}700$$

and this result agrees with the one E. F. S. obtains by using formula (8).

In general it is preferable to use formula (1) rather than a formula based, as (8) is, upon voltage drop, for in an A. C. circuit there is no simple relation between volt line drop and line current, or watts line loss. If the voltage drop must be kept within certain limits, a size of wire can be found by formula (1), and having this wire size the exact voltage drop can be computed from the equation,

$$e = E\sqrt{[(1 + Rg + Xb)^2 + (Xg - Rb)^2]} - E \qquad (15)$$

Where all symbols not otherwise defined have the meanings previously given, and $g = W \div E^2$; $b = g \tan \Theta$; and (X) is the reactance, in ohms of one of the wires of the three-phase system.

An exact formula for wire size can be based upon voltage line drop by solving equation (15 for (R). This formula would be

$$\text{Cir. mils} = [k\ D\ g\ ] \div [\sqrt{G} - \cos^2 \Theta] \qquad (16)$$

Where all symbols are as before and (G) is defined by the auxiliary equations: $G = F \cos^2 \Theta$; $F = \cos^2 \Theta + H$; $H = A - C$; $A = 2P + P^2$; $P = e \div E$; $C = [(B^2 \div \cos^2 \Theta + 2\ B \tan \Theta]$; and $B = g\ X$

Knowing the desired spacing of line wires (X) can be determined closely enough for a first solution of the equations, and can be corrected afterwards if found necessary.

Howard S. Miller, E. E.

Calculating Horsepower of an Air Compressor. Ans. Ques. No. 480.

Editor Electrical Engineering:

A duplex air compressor 10 inch by 18 inch by 12 inch, running at 45 revolutions per minute, has a piston displacement of

$$[(18^2 \times .785 \times 12) \div 1728] \times 4 \times 45 = 318 \text{ cubic feet per minute.}$$

The work done in compressing air to a given pressure is calculated by the formula:

$$\text{H. P.} = .004336\ P_1\ V_1\ [n \div (n - 1)]\ [\ P_2 \div P_1)^x - 1].$$

Where P_1 = Initial pressure, pounds per square inch absolute, P_2 = Final pressure, pounds per square inch, absolute, V_1 = Volume of free air compressed, cubic feet per minute; $x = (n - 1) \div n$ where n is a factor depending upon the efficiency of the cylinder cooling system. Its value varies between 1.25 and 1.35, a fair average being 1.30, for usual conditions.

Substituting in the above formula: $P_1 = 14.7$ pounds per square inch; $P_2 = 22 + 14.7 = 36.7$ pounds per square inch; $V_1 = 318$ cubic feet of free air per minute; $n = 1.30$.

$$\text{H. P.} = .00436 \times 14.7 \times 318 \times [1.30 \div (1.30 - 1)]\ [(36.7 \div 14.7)^{.23} - 1] = 88.3 \times (2.5^{.23} - 1) = 20.3$$

horsepower.

Since the efficiency of the compressor is given as 85 per cent, the indicated horsepower required will be

$$20.3 \div .85 = 23.9 \text{ I. H. P.}$$

We would expect that an engine with a steam cylinder 10 inches by 12 inches, using steam at 125 pounds pressure, would require about 35 pounds steam per I. H. P. hr., hence the total steam consumption will be about 835 pounds per hour.

Similarly, the displacement of the 10 inch by 10 inch by 10 inch single air compressor, running at 60 revolutions per minute is

$$[(10^2 \times .785 \times 10) \div 1728] \times 2 \times 60 = 54.5 \text{ cubic feet per minute.}$$

Substituting in the formula as before

$$\text{H. P.} = .00436 \times 14.7 \times 54.5 \times [1.30 \div (1.30 - 1)]\ [(59.7 \div 14.7)^{.23} - 1]$$

$$= 15.1\ (4.06^{.23} - 1) = 5.74 \text{ horsepower.}$$

The required indicated horsepower of this compressor is

$$5.74 \div .85 = 6.88 \text{ I. H. P.}$$

A steam engine, 10 inches by 10 inches, at 60 revolutions per minute with 125 pounds steam pressure, at this indicated load would use at least 50 pounds per I. H. P.-hr., hence its total steam consumption will be 344 pounds steam per hour.

A chart was published in *Power,* August 18, 1914, and also in *The Compressed Air Magazine,* October, 1914, based on the formula used above, by which graphic solutions of problems similar to the above may readily be arrived at.

Power Demand of Electric Hoists. Ans. Ques. No. 481.

According to the diagram accompanying question No. 481, the loaded car weighs 140,000 pounds, which on a 10 per cent grade would be balanced by a pull of 14,000 pounds on the cable. The friction of the car would be about 30 pounds per ton on 2,100 pounds, making the total load on the cable while hoisting 14,000 + 2,100 = 16,100 pounds. Since the drum is 24½ inches in diameter, and makes 6.44 revolutions per minute, the speed of the car will be

$$[(24\tfrac{1}{2} + \tfrac{7}{8}) \times 3.1416 \times 6.44] \div 12 = 42.7 \text{ feet per minute.}$$

The effective diameter of the drum being taken as its actual diameter plus the diameter of the cable. The horsepower required at the drum is therefore,

$$(42.7 \times 16{,}100) \div 33{,}000 = 20.85 \text{ horsepower.}$$

While this is the information requested it will be of interest to discuss the equipment further. A slip-ring type of motor rated at 30 horsepower should have an efficiency of about 88 per cent, and power factor of about 80 per cent between three-quarters load and full load, so that when taking 75 amperes the power delivered by the motor would be:

$$75 \times 220 \times 1.732 \times .88 \times .80) \div 746 = 26.95 \text{ brake horsepower.}$$

Thus the efficiency of transmission of the gear is, $(20.85) \div 26.95 = 77.4$ per cent.

C. S. Stouffer.

Alessandro Volta was the pioneer in battery work. The Voltaic pile was his production. He also developed the electroscope, one of the finest and simplest of electrical indicating instruments. Volta was an Italian.

CYLINDER PISTON DISPLACEMENTS

IN CUBIC FEET PER REVOLUTION DOUBLE ACTING

Diam. in Inches.	STROKE IN INCHES.															Diam. in Inches.
	6	7	8	10	12	14	16	18	20	22	24	30	36	42	48	
6	.195	.229	.261	.327	.392	.458	.523	.....	.....	.....	.....	.....	.....	.....	.....	6
7	.267	.311	.356	.445	.534	.624	.712	.....	.....	.....	.....	.....	.....	.....	.....	7
8	.349	.407	.465	.581	.698	.814	.930	1.04	1.16	1.27	1.39	1.74	.....	.....	.....	8
9	.442	.515	.588	.736	.883	1.030	1.177	1.32	1.47	1.61	1.76	2.20	.....	.....	.....	9
10	.545	.636	.727	.909	1.090	1.272	1.454	1.63	1.81	2.00	2.18	2.72	3.27	.....	.....	10
11	.659	.769	.879	1.099	1.319	1.539	1.759	1.97	2.19	2.41	2.63	3.29	3.95	.....	.....	11
12	.785	.916	1.047	1.308	1 571	1.832	2.094	2.35	2.61	2.87	3.14	3.92	4.71	5.49	.....	12
13	....	1.075	1.228	1.536	1.843	2.150	2.457	2.76	3.07	3.37	3.68	4.60	5.53	6.45	.....	13
14	....	1.247	1.425	1.781	2.137	2.494	2.850	3.20	3.56	3.91	4.27	5.34	6.41	7.48	8.55	14
15	....	.....	1.636	2.045	2.454	2.803	3.272	3.68	4.09	4.49	4.90	6.13	7.36	8.58	9.81	15
16	....	.....	1.861	2.327	2.792	3.257	3.723	4.18	4.65	5.12	5.58	6.98	8.37	9.77	11.16	16
17	....	.....	.....	2.629	3.152	3.677	4.203	4.72	5.25	5.77	6.30	7 88	9.45	11.03	12.60	17
18	....	.....	.....	2.945	3.534	4.123	4.712	5.30	5.89	6.47	7.06	8.83	10.60	12 36	14.13	18
19	....	.....	.....	....	3.937	4.593	5.250	5.90	6.56	7.21	7.87	9.84	11.81	13.78	15.75	19
20	....	.....	.....	.....	4.363	5.090	5.817	6.54	7.27	7.99	8.72	10.90	13.08	15.27	17.45	20
21	....	.....	.....	.....	.....	5.612	6.413	7.21	8.01	8.81	9.62	12.02	14.43	16.83	19.24	21
22	....	.....	.....	.....	.....	6.159	7.037	7.91	8.79	9.67	10.55	13.19	15.83	18.47	21.11	22
23	....	.....	.....	.....	.....	.....	7.693	8.65	9.61	10.57	11.54	14.42	17.31	20.19	23.08	23
24	....	.....	.....	.....	.....	.....	8.377	9.42	10.47	11.52	12.56	15.70	18.84	21.98	25.12	24
25	....	.....	.....	.....	.....	.....	9.090	10.22	11.36	12.49	13.63	17.04	20.44	23.85	27.26	25
26	....	.....	.....	.....	.....	.....	9.830	11.06	12.29	13.51	14.74	18.43	22.12	25.80	29.49	26
27	....	.....	.....	.....	.....	.....	10.602	11.92	13.25	14.57	15.90	19.88	23.85	27.83	31.80	27
28	....	.....	.....	.....	.....	.....	11.402	12.82	14.25	15.67	17.10	21.38	25.65	29.93	34.20	28
29	....	.....	.....	.....	.....	.....	.....	13.75	15.28	16.81	18.34	22.93	27.51	32.10	36.68	29
30	....	.....	.....	.....	.....	.....	.....	14.72	16.36	17.99	19.63	24.54	29.44	34.35	39.26	30
31	....	.....	.....	.....	.....	.....	.....	15.72	17.47	19.21	20.96	26.20	31.44	36.68	41.92	31
32	....	.....	.....	.....	.....	.....	.....	16.75	18.61	20.47	22.34	27.92	33.51	39.09	44.68	32
33	....	.....	.....	.....	.....	.....	.....	.....	.....	21.77	23.75	29.69	35.63	41.57	47.51	33
34	....	.....	.....	.....	.....	.....	.....	.....	.....	23.11	25.22	31.52	37.83	44.13	50.44	34
35	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	26.72	33.40	40.08	46.76	53.45	35
36	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	28.27	35.34	42.40	49.47	56.54	36
37	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	37.33	44.79	52.26	59.72	37
38	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	39.37	47.25	55.12	63.00	38
39	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	41.47	49.77	58.06	66.36	39
40	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	43.63	52.35	61.08	69.80	40
42	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	67.34	76.96	42
44	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	73.89	84.46	44

II. Horse-Power, Efficiency and Terminal Temperature in Air Compression to Various Pressures.

SINGLE AND TWO STAGE COMPRESSION

Gage Pressures	Atmospheres	Isothermal Compression	Single Stage Adiabatic Compression			Two Stage Compression		
		H.P. required to Compress One Cubic Foot per Minute	H.P. required to Compress One Cubic Foot Free Air per Minute	Efficiency as compared to Isothermal	Final Temperature Degrees Fahr. Perfect Intercoloring Adiabatic Compression	H.P. required to Compress One Cubic Foot Free Air per Minute	Efficiency as compared to Isothermal	Final Temperature Degrees Fahr. Perfect Intercooling Adiabatic Compression
5	1 34	0188	0197	.96	106	....	....	....
10	1 68	0333	0362	93	145		....	....
15	2 02	0481	0505	90	178		....	....
20	2 36	0551	0630	88	207		....	....
25	2 70	0638	075	.85	234		....	....
30	3 04	.0713	085	84	252		....	....
40	3 72	0843	104	.81	302		....	....
50	4 40	0948	120	79	339	109	.87	188
60	5 08	1037	.134	.77	375	121	.86	203
70	5 76	.1120	148	75	405	.131	.85	214
80	6 44	1196	160	.74	432	141	.85	224
90	7 12	1260	171	74	459	.150	.84	234
100	7 80	1320	182	73	485	158	.83	243
110	8 48	1371	192	.72	500	.165	.83	250
120	9 16	1422	202	71	529	.172	.83	257
130	9 84	1467	.210	.70	560	.179	.82	265
140	10 52	1510	218	69	570	186	.82	272
150	11 20	1547	226	69	589	193	.81	279
160	11 88	1583	.231	.68	607	198	.81	285
180	13 24	.1656	.249	.67	640	208	.80	297
200	14 60	1720	263	65	672	217	.79	309
225	16 3	1790	278	.64	715	227	.79	320
250	18	1860	.292	64	749	237	.78	331
275	19 7	.1920	306	63	780	247	.78	342
300	21 4	.1970	317	62	815	256	.77	352
350	24 8	.2060	342	60	867	.272	.76	370
400	28 2	2140	364	.59	915	283	.76	380
450	31 6	2230	381	58	960	295	.75	397
500	35	2290	398	.57	1000	.307	.75	415
550	38 4	.2340	416	56	1040	321	.73	430
600	41 8	240	432	.55	1077	332	.72	442
650	45 2	245	447	.55	1113	345	.71	451
700	48 6	.249	461	.54	1136	.355	.70	458
750	52.	252	475	.53	1178	.363	.69	462
800	55 4	258	488	52	1208	.373	.69	468
850	58 8	.262	.500	.52	1237	.381	.69	480
900	62 2	265	512	.52	1265	.388	.68	490
950	65 6	.268	.523	.51	1292	.395	.68	495
1000	69	.272	.534	.51	1318	.403	.67	498
1100	75 8	278	555	.50	1367	416	.67	507
1200	82 6	283	.575	49	1415	.429	.66	525
1300	89.4	289	594	49	1457	.441	.66	534
1400	96 2	293	611	.48	1498	.452	.65	550
1500	103	297	627	18	1537	.462	.65	563
1600	109 8	301	643	.47	1575	.472	.64	568
1700	116 6	305	659	47	1610	.482	.63	589
1800	123 4	309	673	.46	1645	491	.63	606
1900	130 2	313	687	.46	1678	.500	.63	628
2000	139	317	.701	45	1709	.509	.62	639
2250	154	.324	733	.44	1784	.528	.62	645
2500	171	331	763	.43	1852	.547	.61	654
3000	205.	.342	816	.42	1975	.579	.59	670

Calculating Horsepower of an Air Compressor. Ans. Ques. No. 480.

Editor Electrical Engineering:

The 10 x 18 x 12 duplex air compressor referred to by G. T. B. in the October issue is presumed to be a 10 x 12 duplex steam and 18 x 12 duplex air. In table No. 1, given here, the piston displacement for an 18 x 12 cylinder, double acting in cubic feet per revolution is 3.534. This figure times 45, the rpm of compressor times two for duplex operation, gives 318 cubic feet per minute as piston displacement.

From table No. 2 the horsepower required to compress one cubic foot of free air per minute to 22 pounds gage is 0.068.

Then 318 x 0.068 = 21.6 horsepower. With an efficiency of 85% the Ihp required would be 21.6 ÷ 85 = 25.4 Ihp.

George L. McLean.

Power Demand of Electric Hoist. Ans. Ques. No. 481.

Editor Electrical Engineering:

Referring to questions 469 and 481 of the August and October issues, the writer believes that the data is still in error. Numbering from left to right in the diagram on page 425 of October issue, number 2 pinion has a pitch diameter of 8 inches and 14 teeth giving it a diametral pitch of 1.75; while the gear with which it meshes has pitch diameter of 34 inches and 86 teeth, or a diametral pitch of 2.00. Obviously this is impossible and it would seem that the author of the question in measuring up the apparatus would be more likely to make a mistake in determining the pitch diameters than the number of teeth. I have taken the latter as correct. The drum speed of 6.44 r.p.m. checks with the author's statement of the problem. The effective diameter of the drum = 24½ inches plus the diameter of cable $= 24\frac{1}{2} + \frac{7}{8} = 25\frac{3}{8}$ inches, and at 6.44 r.p.m. the velocity of the car $= (3.1416 \times 25\frac{3}{8} \times 6.44) \div 12 = 42.8$ feet per minute. The power required to pull the car up the incline, without friction equals weight times vertical component of velocity divided by 33,000 foot-pounds per minute or $(140{,}000 \times 42.8 \times 1) \div (33{,}000 \times 10) = 18.15$ horse power. Assuming journal and rolling friction to amount to 1 per cent, which is a reasonable value, the power at the drum $= (18.15) \div 0.99 = 18.33$ horsepower.

Now since Mr. DeWeese has given the amperes input to the motor, let us work it through from that end as a check. From the preceding it is evident that the motor is operating under about 2/3 normal load, in which case, for this size motor and speed, the power factor would be about 67 per cent and efficiency about 80 per cent. The motor input therefore equals $(75 \text{ amps} \times 220 \text{ volts} \times 1.732) \div 1000 = 28.5$ K.v.a., which at 67 per cent power factor $= 28.5 \times 0.67 = 19.07$ K.w. With 80 per cent efficiency this equals $(19.07 \times 0.80) \div 0.746 = 20.45$ brake horsepower at the motor pinion. The gear train contains three drives and under the condition (assuming fairly new and in good shape) we should expect 97 per cent efficiency for each, making a combined efficiency for the train of $0.97 \times 0.97 \times 0.97 = 0.913$ or 91.3 per cent. Then the power at the drum will equal $20.45 \times 0.913 = 18.65$ horsepower.

T. B. Hyde.

Why Field Coils are Connected Ahead of Armature Coils in Street Railway Motors. Ans. Ques. No. 482.

Editor Electrical Engineering:

When the series field winding is connected between trolley and armature it is said to be cut in ahead of the armature. It is generally conceded to be better practice to connect the series field between armature and rail (ground) rather than between trolley and armature. With full load on the motor the voltage drop across the field winding is about 50 volts. If one side of the field is connected to ground and the other to the armature, the field need only be insulated for 50 volts. On the other hand connecting the field ahead of the armature subjects it to full load potential, and the field must be insulated accordingly.

It is also thought that connecting the field ahead of the armature protects the armature from lightning, the field winding acting as a choke coil. The tendency for motors to flash-over or "buck" is also less with the field between trolley and armature. With the field between armature and ground, reversal of rotation of the motor is accomplished by reversing the current through the armature. The majority of companies connect the series field winding between armature and ground. K. R.

Effect of High Frequency on Apparatus. Ans. Ques. No. 483.

Editor Electrical Engineering:

In order to get high frequency alternators with low speeds, it is necessary to have a large number of poles. The speed of all prime movers, especially slow speed ones, varies during a revolution. This means that if two machines are running the same revolutions per minute, the angular positions of their rotors will be a few degrees apart at certain parts of the revolution. Where we have a large number of poles, a small angular difference will be a large proportion of the distance from one pole to the next. For satisfactory parallel operation, it is necessary to have corresponding armature conductors under the middle of corresponding poles at the same instant so that with difference of angular position and a large number of poles, parallel operation is unsatisfactory. The generators can be paralleled if the prime movers have sufficiently uniform speed.

High frequency low speed induction motors are liable to have low power factor. The speed of an induction motor varies directly with the frequency and inversely with the number of poles, so that a high frequency slow speed motor must have a large number of poles. This means that the main flux has to cross the gap several times, once at each pole, requiring considerable magnetizing current to force it through the reluctance of the gap. Magnetizing current is out of phase with the voltage so that large magnetizing current means low power factor. If a high frequency generator is properly designed it will give no more trouble from heating than a low frequency one. However, if a generator is operated at a frequency higher than its rated frequency, trouble will be experienced from heating at no load due to increased iron loss.

R. H. Willard.

Method of Calculating Cost of Power as Generated by Steam. Ans. Ques. No. 484.

Editor Electrical Engineering:

The expense of producing electric power follows the general law of production, that such expense is the sum of the fixed charges and operating costs.

The Fixed Charges are obtained by a method of accounting so that expenditures made directly or indirectly for such items as interest on plant investment, depreciation of plant, taxes, insurance, repairs, rentals, and salaries, which do not depend entirely upon the number of kilowatthours produced in a given time, may be apportioned and shown as a part of the cost of the production of that number of kilowatthours.

The first item, or interest on plant investment, is equal to the rate of interest which the sum invested in the plant would earn if that sum were deposited in a bank or invested in such a way as to actually return a definite percentage in a given time. This rate may vary from 4 per cent per annum, upwards, 8 per cent being generally considered as a fair return on an investment.

The second item, or depreciation, is a sum, expressed as a percentage of the plant investment, charged against the whole or a portion of the plant due to its age. This item is sometimes divided to cover depreciation proper and also obsolescence. This latter term meaning that, due to improvement in the art, the original plant may be replaced because it has become uneconomical to operate as compared with a later type of plant, as for instance, a large steam turbine replacing a reciprocating engine of the same horsepower rating.

The remaining items are self explanatory, and are charged as a fixed sum per year or as a percentage per year on the investment.

Operating Costs are those items which depend upon the number of hours the plant is operated and the number of kilowatthours produced, including such items as wages, materials and supplies.

The following is an example of computing costs in a steam driven plant, as requested by G. T. B. in question No. 484. Of the 21 items listed, 16 are assumed, as but 5 were stated in the question. Consequently, the final costs as computed may require considerable revision to apply to the plant of which G. T. B. writes. The values used have been accumulated from various sources but are believed to be approximately those in current practice, and are conservative.

Plant Data: Rated generator capacity 275 Kw. costing installed $50 per Kw. and located in a structure costing $1,250 erected, for which no rent is charged. Insurance, 0.5 per cent on whole value; taxes, 1.8 per cent on whole value; repairs, 1.7 per cent, and depreciation, 5 per cent. The operating force consists of one engineer in full charge, at $100 per month, and one fireman at $75 per month. No charges for other supervision. The plant will develop 1.0 Kw.-hrs per 8 pounds of coal, costing $3 per ton of 2,000 pounds delivered. Oil and miscellaneous supplies average $10 per month. Water is free and the ashes are removed without extra charge. Demand 230, Kw. Monthly Kw.-hrs. consumed, 62,700.

Plant Investment.

Machinery, 275 Kw. at $50	$13750
Structure	1250
Total	$15000

Fixed Charge per Year.

Interest at 8.0 per cent	$1200
Depreciation at 5.0 per cent	750
Taxes at 1.8 per cent	270
Insurance at 0.5 per cent	75
Repairs at 1.7 per cent	255
Rental at 0.0 per cent	0
Supervision at 0.0 per cent	0
Yearly totals, 17.0 per cent	$2550

$2550 ÷ 12 = $212.50 per month.

$212.50 ÷ 230 = $0.924, fixed cost per Kw. demand.

$212.50 ÷ 62,700 = $0.00339, fixed cost per Kw.-hr.

Operating Costs per Month.

Wages	$175.00
Supplies	10.00
Coal (62700 × 8) ÷ 2000 = 250.8 tons at $3	752.40
Total operating costs	$937.40

$937.40 ÷ 62,700 = 1.495 cents per Kw.-hr.

Total Expense.

	Per Month.	*Per Kw.-Hr.*
Fixed charges	$ 212.50	0.339 cents.
Operating costs	937.40	1.495 cents.
Combined	1,149.90	1.834 cents.

As these costs are based on assumed values mainly, no further discussion will be undertaken.

Purchased Current.

Demand charges, 230 Kw. at $2.00, $460.00.

Running cost for total kilowatt hours of 62700.

1st block	500 @ 4.5 cents,	$22.50
2nd block	4500 @ 2.5 cents	112.50
3rd block	45000 @ 1.0 cents	450.00
Balance	12700 @ 0.9 cents	114.30
Total running costs		$699.30

Average per Kw.-hr., 1.115 cents.

Total bill for current.

Demand	$ 460.00
Running	699.30
	$1,159.30

Average per Kw.-hr. 1.849 cents.

Referring to the latter portion of Mr. G. T. B.'s question, concerning the use of a rotary converter, if the power is metered on the A. C. side, the customer generally buys the converter and assumes the cost of the losses. If the power is metered on the D. C. side, the supplying company furnishes the set and assumes the losses.

The question as to which would result in the lower rate for power would depend upon the various schedules used in contracting for current.

A converter of 200 Kw. rating would probably be large enough for this installation and would have an efficiency of about 92 per cent from A. C. primary mains to the d. c. mains.

R. Arthur Joslyn.

Method of Calculating Cost of Power as Generated by Steam. Ans. Ques. No. 484.

Editor Electrical Engineering:

In answer to question No. 484 in the October issue of *Electrical Engineering*, the writer gives the following calculations based upon data given and assumed as follows:

From data given: One 320 horsepower engine drives one 200 Kw. d. c. generator and one 120 horsepower engine drives a 75 Kw. d. c. generator. Plant operates non-condensing. Coal costs $3.00 per ton. Water taken from river. Maximum demand 230 Kw. Average monthly consumption 62,700 Kw.-hrs.

From data estimated and assumed: Steam consumption of 320 horsepower engine 26 pounds per Ihp-hr. and for 120 horsepower engine 30 pounds per Ihp-hr. Plant runs 10 hours per day or 308 days per year. Factor of evaporation 1.15. One pound of coal evaporates 7.5 pounds water. Stand-by losses 10 per cent. Fixed charges consisting of repairs, renewals, interest, depreciation and taxes at 11 per cent.

CALCULATIONS TO SHOW COSTS.

(1 and 2) Water and Coal Required.

Load Factor = (Average load for given period) + (Rated capacity for same period)
= 62,700 Kw.-Hrs. + (275 Kw. × 10 Hrs. × 26 days mo) = 87 per cent

Cu. Ft. Water per day = (Load factor × Hp. × lbs. steam per Ihp-Hr × Hrs. per day) ÷ 62.5
= (.87 × 320 × 26 × 10) ÷ 62.5 = 1156
= (.87 × 120 × 30 × 10) ÷ 62.5 = 501
Total = 1156 + 501 = 1657 cu. ft.

Allowing 10 per cent for auxiliaries and leakage, the total water required is then 1657 ÷ .90 = 1840 cu. ft.

Lbs. of coal required = Lbs. water required × factor of evaporation) ÷ (Lbs. water evaporated per lb. of coal.)
= (1840 × 62.5 × 1.15) ÷ 7.5
= 17,666 lbs. per day or 8.83 tons.

(3 and 4) Oil and Waste Required.

Total Hp-Hrs. per day = .87 × 440 × 10 = 3830.

Assuming 1.014 pints of cylinder and engine oil per 1,000 Hp-Hrs., then:

Oil required = 1.014 pts. × 3.83 = 3.88 pts. or 0.485 gals.

Assume 21 lbs. of waste per day at a cost of 8.5 cents per lb.

(5) Labor Required.

One chief engineer	@	$100 per month.
One assistant	@	70 per month.
One fireman	@	60 per month.

One assistant @ 45 per month.a

Total.............$275 per month.

(6) Fixed Charges.

1—320 Hp. engine erected, including foundation	$5,000.00
1—200 Kw. d. c. generator	2,000.00
1—120 Hp. engine erected, including foundation	2,700.00
1—75 Kw. d. c. generator	1,000.00
Switch board equipment	1,000.00
2—boilers 300 Hp. each, including setting	6,200.00
Brick-stack and flues	2,400.00
2—Feed pumps	700.00
2—Feed-water heaters	500.00
Piping	2,000.00
Boiler house	3,000.00
Engine house	2,000.00
Coal-pocket	1,200.00
Incidentals	2,300.00
Total cost of plant	$32,000.00

TOTAL OPERATING COST PER DAY—308 DAYS PER YEAR, 10 HRS. PER DAY.

1. Water	———
2. Coal: 8.83 tons at $3.00 per ton	$26.50
3. Oil: Cylinder oil—.485 gal. at $.60 per gal.	.29
Engine oil—.485 gal. at $.35 per gal.	.29
4. Waste: 2 lbs. at $.085 per lb.	.17
5. Attendance: (275 × 12) ÷ 308	10.71
6. Fixed charges: 11 per cent on 32,000	11.40
Total	$49.36

Then $49.36 × 308 = $15,200 per year operating cost. Also 62,700 × 12 = 752,400 Kw. per year total consumption. Therefore 15,200.00) ÷ 752,400 = 2.02 cents per Kw. hr. as generating cost for the plant.

COST OF CENTRAL STATION POWER.

Primary charge:

1st. 10 Kw. demand at $3.50 per Kw.	$ 35.00
2nd. 40 Kw. demand at $2.50 per Kw.	100.00
3d. 180 Kw. demand at $2.00 per Kw.	360.00
500 Kw. hrs. at $.045	22.50
4,500 Kw. hrs at $.025	112.50
45,000 Kw. hrs at $.010	450.00
12,700 Kw. hrs. at $.009	114.30
62,700 Kw. hrs.	1,194.30

$$\frac{1194.30}{62700} = 1.91 \text{ cents per Kw. hr.}$$

Summary:

Cost of central station power.....1.910 cents per Kw. hr.
Cost of steam plant power.—(estimated largely) ....2.020 " " " "
Difference ....0.110 " " " "

If a rotary converter is installed and central station power is used, it is customary for the customer to buy the machine. The power is metered on the d. c. side so that customer pays the converter losses. A 300 Kw. converter would take care of the present load and allow for a future increase in current consumption. The per cent losses would depend to a large extent on the per cent load. The converter losses per month probably would not exceed 10 per cent of the total Kw. hr. consumption per month.

At .01 per kw.-hr. this would be .01 × 6270 = $62.70 per month.

J. J.Kojan.

Causes of Sparking of D. C. Generator. Ans. Ques. No. 488.

Editor Electrical Engineering:

Anything that causes an unequal distribution of current in the brushes of the same polarity on a D. C. generator will cause sparking and burning of the commutator. If the brushes are improperly spaced a heavy short circuited current will be set up in the coil under the brushes not on the electrical neutral. This heavy short circuited current will oppose the armature current flowing through the brushes and cause the other brushes of the same polarity to carry more than their share of the load.

In the same way unequal brush tension will throw the current to the other brushes of the same polarity, thereby overloading them and causing them to spark. An electrically unbalanced armature, caused by a mistake in winding; a bad splice in a belt or the lateral motion of the armature will also cause burning of the commutator and sparking of the brushes.

H. H. Wikle.

Causes of Sparking of D. C. Generators. Ans. Ques. No. 488.

Editor Electrical Engineering:

It is the writer's opinion that the trouble mentioned by C. A. H. in question 488 of the November issue, is due to hard mica in the commutator. The location of these spots around the commutator does not necessarily indicate anything further than the location of the hard mica. It will probably be found when these spots begin to develop, if you scrape your fingernail over the bad spots that you can feel the mica raised slightly above the copper. The fact that the sparking takes place under the negative brushes would indicate the presence of a certain amount of electrolytic action, probably due to the presence in the air of some chemical, either in the form of a gas or a powder, which has a tendency to produce this action. Cases of this kind have come to the writer's attention. The remedy is, of course, to undercut the mica (only a shallow *V* groove) and install graphite brushes or at least some grade of brush which will not wear the copper.

W. R. Smith.

United Electric Light and Power Co., of New York City, Issues Book of Electric Appliances.

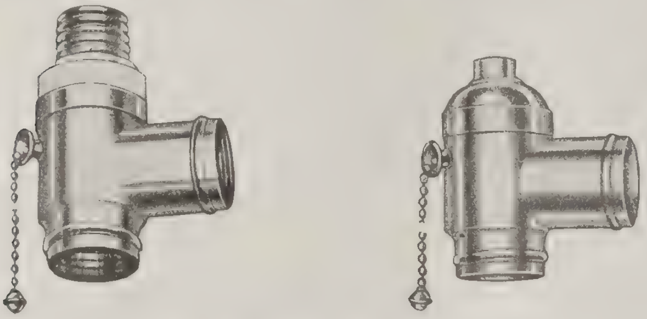
The United Electric Light and Power Co., of New York City, has recently issued a 48 page book which gives illustrations, data and prices of all popular electric appliances for the home and office. On the first page facing the inside of the cover a letter is addressed to customers inviting them to visit the company's show room. This, is followed by several illustrations of the office and show rooms, and next a table of contents of the book. While different makes of equipment are shown, the names of manufacturers are not metnioned, and the price given is the net price as sold at the company's show room. The name of the company is printed at the top of every left-hand page and the address at the top of every right-hand page.

This catalogue represents a unique new business proposition and an excellent advertisement for the company.

New Apparatus and Appliances

Bryant Twin Pull Sockets.

A design of pull socket with outlets for two lamps has been made by the Bryant Electric Company of Bridgeport, Conn. This socket is made in two types. In one type both outlets are simultaneously cut on or off by successive pulls of the chain. In the other type the straight outlet alone is affected when the chain is pulled, the lamp in the angle outlet being on all the time. The first type is useful where it is desirable to turn on and off two energy-consuming devices at the same time or where one outlet holds a lamp which serves as a pilot lamp for an appliance connected to the other outlet. The second type is useful when it is desired to have a lamp or other energy-consuming device equipped with its own switch connected to the angle outlet. A shade holder can be attached to either outlet and can be held in its normal position relative to the lamp. An attachment plug may be substituted for one lamp or two attachment plugs may be used instead of two lamps.



Bryant Twin Pull Socket.

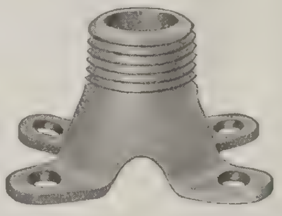
A New Thor Washing Machine.

A new design of Thor washing machine has been produced to insure safety for even the most careless operator. There are no chains or belts to catch the fingers or clothes and every moving part is enclosed. The wringer is so arranged so that it is impossible to get the fingers caught in the rolls, thus making accidents from this source impossible. Power is supplied by a Westinghouse small motor which can run the washer and the wringer at the same time. Two switches, one for the washer and one for the wringer, control the operation of the whole machine. The machine is manufactured by the Hurley Machine Co., Chicago.

The Thor Washing Machine.

Stamped Steel Fixture Studs.

The accompanying illustration shows a design of sherardized fixture stud now being made by the National Metal Molding Company of Pittsburgh, Pa. This stud is stamped from high grade mild steel of No. 11 B and S gage, which is sufficiently thick to permit the hollow stems of the male stud being tapped to make female studs. Also the female studs can be threaded and made into male studs.



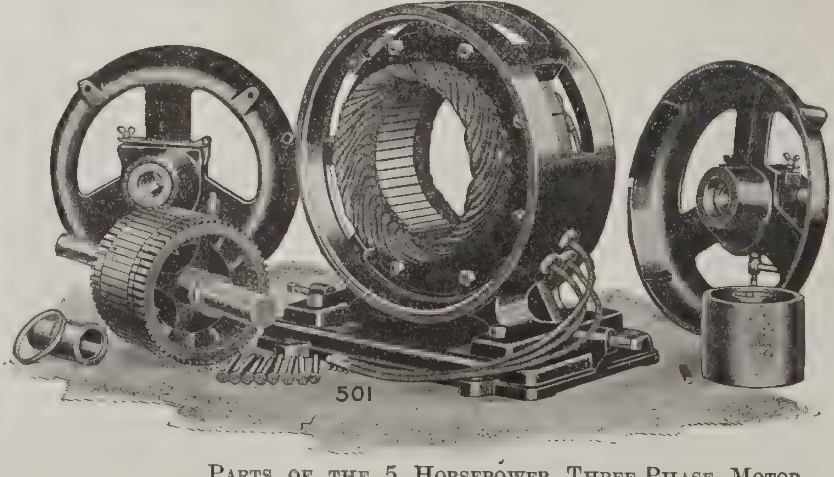
Stamped Steel Male Fixture Stud.

The shape of the studs permits their being used with the stems passing through the center of knockouts of outlet boxes, insuring greater security when hanging heavy fixtures.

Robbins and Myers Induction Motors.

The Robbins & Myers Co., of Springfield, Ohio, has recently completed the development of a new line of polyphase induction motors, ranging in size from ¼ to 7½ horsepower inclusive. They are supplied for operation on two or three-phase, 110, 220, 440 and 550 volt circuits of all commercial frequencies. The frame of these motors consists of a cast iron skeleton type shell which supports the stator. This exposes the stator core to the air and gives thorough ventilation. The end heads are cast separately from the frame, machined to fit the frame and attached by four machine screws.

The stator is built up of soft, annealed steel laminations which are held together by bolts. The rotor is the squirrel cage type. The core is built up of steel lamina-

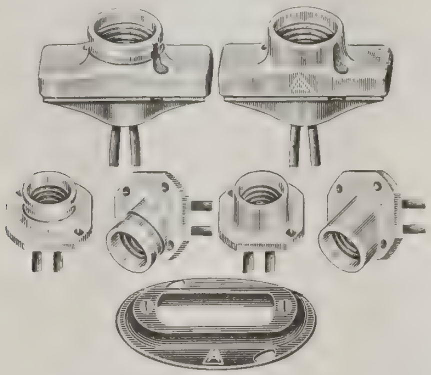


Parts of the 5 Horsepower Three-Phase Motor.

tions which are keyed to a cast iron spider. The rotor bars are connected to the end rings which are recessed to fit them, by double riveting and soldering. The terminals are brought out through holes in the frame which are suitably bushed with insulating material. Each motor is furnished with a sliding base and cast iron pulley. They can also be supplied with idler pulley attachments or back gears if so desired.

New Appleton Fittings.

The accompanying illustrations show a number of new fittings produced by the Appleton Electric Co., Chicago, Ill. These include one piece weatherproof porcelain receptacles for use with rectangular and octagon steel "Unilets" that can be secured by two screws. These devices as shown are produced in designs with and without shadeholder groove.



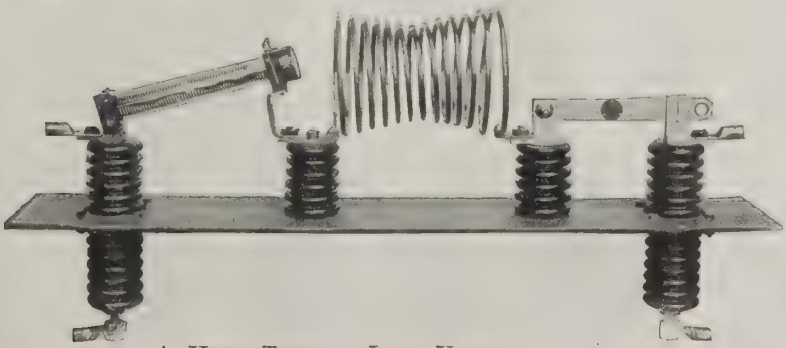
New Appleton Fittings.

A push button switch cover for outlet boxes is also produced for use on four inch round outlet boxes and to take any of the standard push button switches, flush rotary switches or plug receptacles.

High Tension Line Unit.

A demand for inexpensive, compact and easily installed units for high tension feeders, has resulted in a design of self-contained line unit shown in Fig. 1. This unit is connected directly in the incoming or outgoing feeder circuits, thus comprising a switching, fusing and choke coil installation. The fuse is of the chemical form, having a high rupturing capacity, thus affording protection to circuits supplied by the largest generating station. The switch is of the disconnecting form, operated by an insulated hook stick and the choke coil is of a powerful type forming an effective barrier between the apparatus and the incoming surges.

This compact unit is made for all voltages up to 33,000, and furnished in many different combinations of front and back connected designs. The steel base is arranged for mounting on either flat surfaces or pipe frame-work and can be grounded, thus affording absolute safety to the operator. This new line of equipment is manufactured by the Delta Star Electric Company of Chicago.

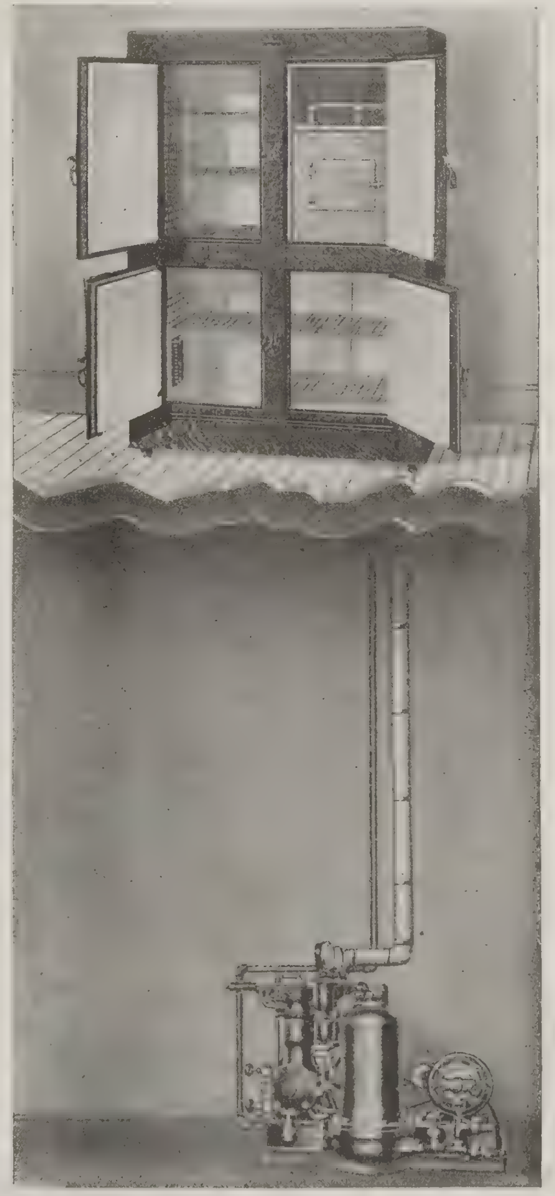


A High Tension Line Unit.

The Blizzard System of Refrigeration.

The accompanying illustration shows a complete refrigerating system, manufactured by the Lueck Manufacturing Company, of Milwaukee, Wisconsin, with the exception of the brine tank, evaporating coils (which go inside of the refrigerator) and automatic devices. This is an ammonia compression machine with the compressor, condenser, oil separator and scale trap all of semi-steel construction and are mounted on one base together with a motor. The condenser is of an improved type embodying the counter current principle by the addition of a device preventing the escape of gaseous ammonia until liquified, to the expansion valve.

The automatic devices consist of the following mechanism, electrically controlled: 1. A thermostat or temperature regulating device mounted in the refrigerating compartment, and set to regulate the temperature at any de-



The Blizzard System of Refrigeration.

sired degree. This instrument controls the switch, which stops and starts the motor as the temperature conditions require. 2. An electric controller, to stop and start the motor by actuation of the thermostat. 3. A water valve, automatically turning on and shutting off the water supply when the machine starts and stops. 4. A high pressure safety device, that shuts off the motor when the pressure exceeds a predetermined limit by reason of shortage of water supply or accidental closing of valves in the system, beginning operation again only under normal pressure.

The system can be installed in connection with any refrigerator now using ice, with very little change as the machine can be placed in any convenient room, preferably in the basement.

The Paragon Time Switch.

A design of time switch has been produced by the Paragon Electric Co., of Chicago, Ill., for use on window display, outdoor street ligthing, apartment house hall and other similar circuits. This switch consists of a high grade clock, a spring motor and switch, the latter being the regular snap switch in designs up to 30 amperes.

The Paragon Time Switch.

The adjustment feature covers a great variety of arrangements. It can be set to turn the lights on at a predetermined hour and turn them off again at the proper time. It will turn on part of the lights and later the rest, or it will turn off part of the lights and finally the balance. It does this every day in the week or it can be adjusted to skip one day, as Sunday for example. It only requires winding once a week and as the case is securely locked, it cannot be tampered with. The door of the case closes against a rubber gasket making it damp or dust proof. All the outdoor models are equipped with a heating coil and regulating thermostat. This prevents hardening of the oil and consequent clogging of the works in severe weather.

New Types of Tungsten Lamps Added to Lux Mfg. Company's Line.

Two new types of tungsten lamps have been added to the line of lamps marketed by the Lux Mfg. Company of Hoboken, N. J.

The first of these new developments is a nitrogen filled tungsten lamp with a filament specially designed for high temperature operation. This lamp is known as the Nitro lamp. The second development is a concentrated filament, round bulb lamp, specially suited to projector work where an extremely concentrated source of light is desirable. These two new types of lamps together with a drawn wire tungsten filament type makes the Lux line complete.

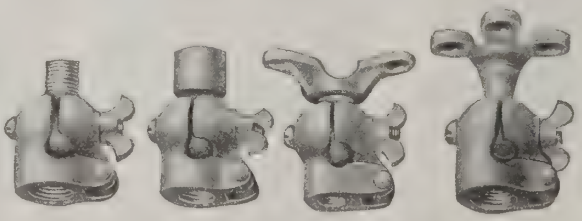
The Nitro lamp is made in wattages from 200 to 1500. The life of these lamps is guaranteed to exceed 1000 hours, and the energy economy is extremely high. The lamps are adapted to outdoor lighting such as streets, parks, railroad yards, factory yards, etc.; outdoor display lighting of theaters, amusement parks, advertisements, etc.; indoor lighting of large spaces, such as drill halls, auditoriums, shops, train sheds, etc; also in places where white light is necessary for color matching.

New Type of Lux Tungsten Lamp.

The concentrated filament lamp is made in sizes ranging from 20 to 150 watts. The life is guaranteed to exceed 1000 hours and the average efficiency is extremely high, requiring only from .08 to 1.0 watt per candlepower, while the ordinary tungsten lamp even when new requires from 0.9 to 1.25 watts per candlepower. Lux concentrated filament lamps are said to be especially suited for operation with projection lamps and reflectors, also to withstand rough service, such as encountered in train lighting, automobile lighting or lighting in any place where excessive vibration is present.

Wico Hang Straight Hickey.

An adjustable ball and socket joint hickey with an angle of possible correction sufficient to take care of a fixture 12 inches long that may be 4 inches off center, or a 6 foot fixture 24 inches out of plumb has been designed by the Wilton Mfg. Co., of Wrightsville, Pa. This new hangstraight higkey is made of high grade malleable iron and furnished with a tripod, crow-foot or outlet box stud or made to fit insulating joints, the bottom of which may be either male or female, ¼ inch or ⅜ inch standard pipe size, and to connect to fixture stems of ⅛ inch, ¼ inch or ⅜ inch standard pipe size. The minimum overall length of this hickey with an insulating joint is less than one

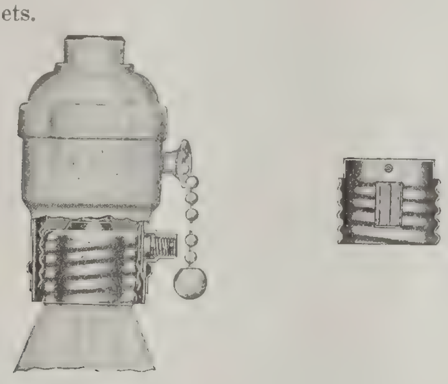


A New Hangstraight Hickey.

inch greater than the ordinary hickey and insulating joint. As a time saver a 10 per cent to 50 per cent reduction on the average cost of hanging electric fixtures is claimed. One man can handle any fixture not too heavy to lift. Long arm, wide spread fixtures are just as simply and easily hung as the plain stem fixture as there is no turning or twisting of the fixture necessary. After the crow-foot or insulating joint with the ball fitting has been attached, the fixture is hung by slipping the bolt through the hole in the ball, swinging up the hinged half of the cup or socket and screwing up the wing nut. The fixture hangs plumb and cannot twist or swing. A tightening of wing nut leaves the joint rigid.

A Lock Socket.

A locking device designed to prevent loss of lamps through theft and also to prevent the use of high wattage lamps, heating devices and other current consuming devices where such articles are not intended to be used, has been placed on the market by the Arrow Electric Company of Hartford, Conn. The device is known as the "Arrolock" and furnished attached to any of the above company's brass shell sockets.



The Lock Socket Showing Locking Device.

As shown in the accompanying illustration the locking feature consists of a small set screw arranged so as to be turned in against a serrated hardened steel clamping piece that engages with the lamp base and prevents the latter from being turned in the socket. A special key is used to operate the set screw.

Electrical Construction News

This department is maintained for the benefit of contractors, dealers, manufacturers and consulting engineers.

ALABAMA.

ANDALUSIA. The Andalusia Light & Power Company has been incorporated with a capital stock of $15,000. By J. D. Henderson and others.

CENTERVILLE. The Centerville Light & Power Co., expects to construct about 5 miles of transmission line. O. C. Oakley is president.

GAYLESVILLE. The installation of a municipal plant is under consideration.

OPELIKA. The Carmack Railway & Power Co. is planning to construct a power house at Lake Carmack. Work on the construction of a railroad from Opelika to Auburn, a distance of 7 miles, is to be started as soon as arrangements for financing are completed. H. A. BeDell of Opelika is president.

GEORGIA.

ACWORTH. The city plans to install an electric driven pump. W. M. Gorgan is chairman of the Water & Light Commission.

LAGRANGE. The Columbus Power Co., is planning to build a substation of 600 Kw. capacity at LaGrange, Ga. Power will be taken from the transmission line of the Goat Rock plant.

MOULTRIE. The city is planning to install a 450 horsepower engine with 312 Kva., 60 cycle, 2,300 volt generator. J. M. George is superintendent of the Water and Light Commission.

ROCKMART. The city plans to install additional steam equipment in its light plant. A 200 horsepower, 4-valve engine will be installed.

KENTUCKY.

CLAY. The Clay Light & Ice Co., plans to install a four mile transmission line and additional street lighting. A 150 horsepower engine and a 60 Kw., single-phase, 60 cycle, 2,200 volt generator, with exciter and switchboard, will be installed in the power plant.

COVINGTON. The South Covington and Cincinnati Street Railway is to install a new substation equipment, containing two 1,500 Kw. synchronous rotary converters, and six 125 Kva. transformers, two switchboards, and accessories.

IRVINE. A franchise has been secured by C. I. Flynn to install an electric plant.

VINE GROVE. The Citizens Lighting Company plan to install additional equipment in their power house. Carl Starder is secretary and treasurer.

MISSISSIPPI.

POLARVILLE. The city is to purchase electric meters for its circuits and will receive bids on about 200. Further information can be secured from M. H. Hall, superintendent.

JACKSON. The city is considering plans for the installation of a municipal street lighting plant.

NORTH CAROLINA.

DURHAM. The Southern Power Company is planning to erect an auxiliary steam plant of 10,000 horsepower on a tract of land purchased between Durham and University Station.

TENNESSEE.

FULTON. The South Fulton Light & Power Company has been incorporated by W. D. Morehead, G. H. Skeen, and Herbert Carr.

NASHVILLE. The Nashville Railway & Light Co., is to install new equipment in a substation consisting of a 500 Kw. motor generator set.

NASHVILLE. According to reports the Tennessee & Kentucky Interurban Electric Railroad Co., is to build a line from Nashville, Tenn., to Adairsville, Ky., a distance of 45 miles, by way of Goodlettsville, Whitehouse, Cross Plains, Orlinda and Lamont. The construction cost will be around $786,000 and power will be purchased from the Nashville Railway & Light Co. J. C. Helms is president of the company, A. G. Merritt, Jr., vice-president; C. G. Denton, secretary, and H. L. Sperry treasurer.

NEWPORT. The city has voted $5,000 to make improvements to its lighting system.

PORTLAND. The Franklin Electric Light & Ice Co., is planning to construct a transmission line to Portland, a distance of 12 miles.

PERSONALS.

MR. ROSS B. MATEER who for some time has held the position of commercial agent of the Southern Sierras Power Company has recently been appointed superintendent of the San Jacinto-Hemet-Winchester-Lakeview district in California which work he will handle in addition to his regular commercial work. This gives Mr. Mateer charge of the Southern California territory of the company with commercial headquarters at Riverside and operating headquarters at San Jacinto. Mr. Mateer has had an extensive experience in operating and commercial work being formerly associated with the Denver Gas and Electric Company as electrical engineer and as commercial engineer with the Great Western Power Company before going with the Southern Sierras Power Company.

THE ENGINEERING DEPARTMENT OF THE NATIONAL LAMP WORKS OF GENERAL ELECTRIC COMPANY, Cleveland, announces the publication of a new bulletin entitled "The Successful Handling of the Small Consumer in Europe" by Mr. S. E. Doane, Chief Engineer of the National. This bulletin is a reprint of Mr. Doane's paper which was presented at the National Electric Light Association convention this year in Philadelphia, and which has been published in full in the Electrical World. It is certain to be of exceptional interest to electrical men in general and to central station men in particular. It covers fully the methods which are in practice in European countries in regard to making a paying proposition of even the smallest consumer.

DR. J. A. L. WADDELL and MR. JOHN LYLE HARRINGTON announce the dissolution of the firm of Waddell & Harrington. The firm's business will be conducted as usual till the conclusion of its affairs in July, 1915, except that it is accepting no new commissions. Dr. Waddell will give his attention to special engineering and financial matters and to important advisory work. Mr. Harrington will be joined by the firm's Associate Engineers, Mr. E. E. Howard and Mr. Louis R. Ash, in the establishment of the firm of Harrington, Howard and Ash.

Messrs. John Lyle Harrington, E. E. Howard, and Louis R. Ash have established the firm of Harrington, Howard and Ash, and will conduct a general consulting practice similar to their past work, including hydro-electric developments, advisable municipal engineering, appraisals, examinations, and reports upon engineering projects, giving special attention to foundations, bridges, particularly movable spans, and other structures in steel and reinforced concrete.

Mr. Harrington has spent many years in bridge and structural shops, two of which he designed and operated, in the service of railroad companies, and in mechanical and electrical work. For three years he was executive engineer of the C. W. Hunt Company of New York, and for two years he was chief engineer and manager of the Locomotive and Machine Company of Montreal, the American Locomotive Company's Canadian subsidiary. For the past eight years he has been a member of the recently dissolved firm of Waddell & Harrington, consulting engineers, Kansas City, Missouri, and in that capacity has developed the vertical lift bridge and directed the design and construction of many millions of dollars' worth of important bridge work.

Mr. Howard has been associated with Dr. J. A. L. Waddell for fourteen years, for many years Principal Assistant Engineer and later Associate Engineer of the firm of Waddell & Harrington. His experience covers every phase of the firm's work, at various times directing the office work, having general supervision of field operations, and serving generally in executive capacity.

Mr. Ash has also had many years' experience in engineering work, and from July, 1910, to April, 1913, was city engineer of Kansas City, Missouri, in which capacity he was responsible for the design and construction of large undertakings covering several million dollars' worth of sewers paving, grading, flood protection work, etc. He also made an appraisal of the property of the Metropolitan Street Railway Company and was engineering adviser for the City in the street railway franchise negotiations. Mr. Ash resigned the office of city engineer to become Associate engineer and office manager of Waddell & Harrington.

The principal office of the new firm will be in the Orear-Leslie Building, 1012 Baltimore Avenue, Kansas City, Missouri.

The Brooklyn Citizen of October 19, 1914, published in its "Who's Who Column," the following concerning Mr. Harry P. Wood. Mr. Wood is well known to the engineering world and this sketch should be of interest to our readers:

"Harry P. Wood, operating engineer of the Edison Electric Illuminating Company, of Brooklyn, was born at Calais, Maine, 1871. He has been chief engineer for the Rockingham Light, Heat and Power Company of Portsmouth, New Hampshire, and one of the erecting engineers of the equipment of Waterside Station No. 1, New York Edison Company. He has served in an operating capacity for the Boston Edison Company and the Brooklyn Rapid Transit Company, coming to the Brooklyn Edison Company in April, 1906. He directs steam and electrical operation for that company and is never out of touch with their system, day or night.

"He is a member of the Modern Science Club, the Crescent Club, Brooklyn Lodge of Elks, Kismet Temple of the Mystic Shrine, American Society of Mechanical Engineers, American Society of Electrical Engineers, Association of Edison Electric Illuminating Companies, and the National Electric Light Association. He is a member of various committees in several of these organizations. He is also a frequent contributor to technical magazines on engineering subjects and frequently called into consultation by engineering companies."

BOOK REVIEWS.

AMERICAN HANDBOOK FOR ELECTRICAL ENGINEERS. compiled by Harold Pender and 26 associate engineers. Published by John Wiley and Sons, 432 Fourth ave., New York City. 2,050 pages in morocco binding. Price, $5.00.

The engineering profession has been fortunate in the past in being able to reap the benefit of the experience of others through the compilation of data and results by tests in such handbooks as Kent's and Foster's. These two names alone describe something definite and authoritative to every engineer. With the good features of these handbooks as a guide and their shortcomings as an incentive, the AMERICAN HANDBOOK AND ELECTRICAL ENGINEERS has been compiled and is truly a monument to present day engineering and the practical knowledge of same gained by the successes and failures of the engineers and investigators of this country. The writer of this review has had occasion to search for and compile data on various electrical topics at the request of readers of ELECTRICAL ENGINEERING and been disappointed to find so little practical and specific information available being forced to depend upon general statements of little value without full knowledge of all conditions. In reviewing this work it has been gratifying to note especially that this viewpoint has been carefully handled by the editors of the handbook. This is especially noted in the presentation of cost data, regarding which the average operating engineer without installation and construction experience is always at sea. Engineers of manufacturing companies have been liberal in furnishing this information and have been responsible for much of the data available. Acknowledgement of this fact is made in this handbook by the selection of eight associate editors from engineering staffs of manufacturing companies.

The arrangement of material is also worthy of mention in that an alphabetical order has been followed with a list of related articles given under each heading. This arrangement, together with a most complete index makes the contents of the work most accessible. In each case also a list of authoritative references are given as a bibliography. Considerable attention has been given to mechanical and civil engineering subjects closely related to electrical engineering practice.

The following engineers have been responsible for the contents of the handbook: William A. Del Mar, Asst. Eng., N. Y. C. & Hudson River R. R., New York City; E. A. Ekern, Engineer Chas. T. Main, Boston; H. M. Goodwin, Prof. of Physics and Electrochemistry, Mass. Inst. of Tech.; W. S. Gorton, Johns Hopkins University; Stephen Q. Hayes, Electrical Engineer, Westinghouse Elec. & Mfg. Co.; L. F. Howard, Chief Engineer, Union Switch & Signal Co., Swissdale, Pa.; R. G. Hudson, Massachusetts Institute of Technology; William Kent, Consulting Engineer and Author of Kent's "Mechanical Engineer's Pocketbook," New York City; E. A. Lof, Engineer, General Electric Co.; S. G. McMeen, President, Columbus Railway & Light Co.; Taliaferro Milton, District Engineer, Elec. Storage Battery Co., Chicago; L. E. Moore, Engineer of Bridges and Signals, Mass. Public Service Commission; Harold Pender, Professor of Electrical Engineering, University of Pennsylvania, Formerly Director of Electrical Engineering Research, Massachusetts Institute of Technology; R. A. Philip, Chief Electrical Engineer, Stone & Webster Eng. Corp; G. W. Pierce, Asst. Prof. of Physics, Harvard University; H. R. Ranken, Engineering Dept., Leeds & Northrup Co., Philadelphia; L. T. Robinson, Engineer, General Electric Co.; David B. Rushmore, Engineer, General Electric Co.; George E. Russell, Assoc. Prof. of Hydraulic Engineering, Mass. Inst. of Tech; Arthur Simon, Electrical Engineer, Cutler-Hammer Mfg. Co., Milwaukee, Wis.; W. I. Slichter, Prof. of Electrical Engineering, Columbia University; C. M. Spofford, Prof. of Civil Engineering, Mass. Inst. of Tech.; Cabot Stevens, Engineer, Stone & Webster Eng. Corp.; M. DeK. Thompson, Associate Professor of Electrochemistry, Mass. Inst. of Tech.; H. F. Thomson, Sec'y of Electrical Engineering Research, Mass. Inst. of Tech.; W. E. Wickenden, Asst. Prof. of Electrical Engineering, Mass. Inst. of Tech.

D. H. B.

STEAM POWER PLANT ENGINEERING, by G. F. Gebhardt, Prof. Mechanical Engineering, Armour Institute of Technology, Chicago, Ill. Fourth Edition. 989 pages; 606 figures. Price, $4.00. Published by John Wiley and Sons, 432 Fourth Ave., New York city.

This work was first published in 1908 but development work in steam power plant engineering has been so rapid as to require a revision of parts of the material. In doing this the author has added much new material, and the book as it now stands is one of the most complete of its kind in existence. While the work was originally intended as a text book, in its present form it is no less than a combination of text book and handbook material in such a well balanced proportion as to make it most valuable to the man desiring a reference to which he can refer for principles of operation and data as well.

One of the most valuable sections of the book to the operating engineer and manager alike, we believe to be the one on "Cost of Power." This section takes up a practical discussion giving tables and estimates on operating costs, discussing labor, attendance, wages, cost of fuel and supplies, maintenance, and fixed charges. Also a large number of operating charts, load curves, etc., are given showing operating practice and results in steam plants.

The book is divided into 21 chapters with appendices A to H. as follows: 1. Elementary Steam Power Plants. 2. Fuels and Combustion. 3. Boilers. 4. Smoke Prevention, Furnaces and Stokers. 5. Superheated Steam and Superheaters. 6. Coal and Ash-Handling Systems. 7. Chimneys. 8. Mechanical Draft. 9. Reciprocating Steam Engines. 10. Steam Turbines. 11. Condensers. 12. Feed-Water Purifiers and Heater. 13. Pumps. 14. Separators, Traps, Drains. 15. Piping and Pipe Fittings. 16. Lubricants and Lubrication. 17. Testing and Measuring Apparatus. 18. Finance and Economics—Cost of Power. 19. Typical Specifications. 20. Typical Steam Turbine Stations. 21. Typical Modern Isolated Station.

No man who desires to school himself in good practice in steam engineering can afford to be without this book.

THE DELTA-STAR ELECTRIC COMPANY, of Chicago, are distributing special publication No. 14, containing extracts from a paper read before the Indiana Electric Light Association. Considerable data is given as to the method of installing outdoor sub-stations, their cost, operation, etc.

Stack

OF THE
UNIVERSITY OF ILLINOIS
8 DEC 1914

DECEMBER, 1914

ELECTRICAL ENGINEERING

Volume XLVI.
Number Twelve.

Published monthly at
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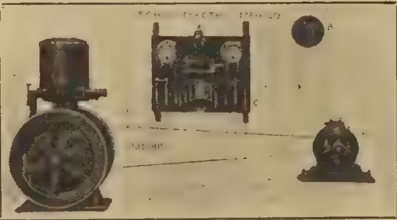

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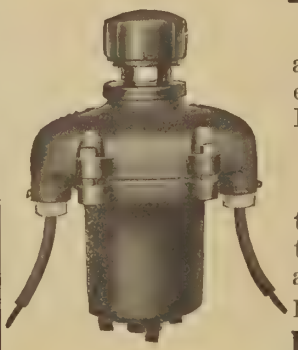

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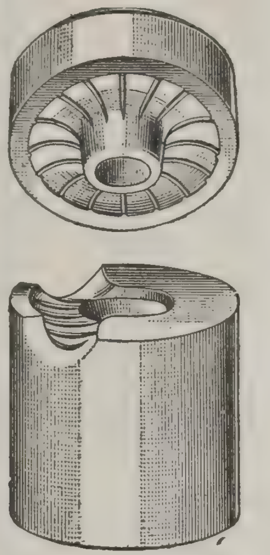

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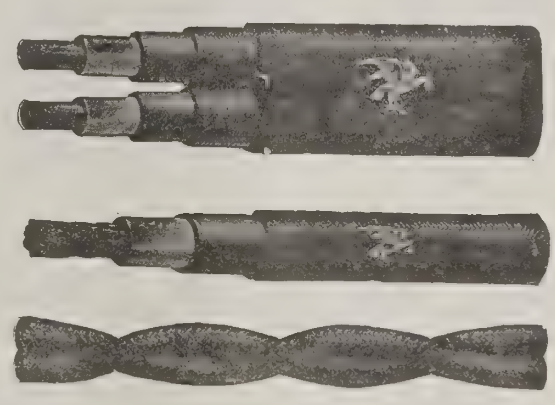

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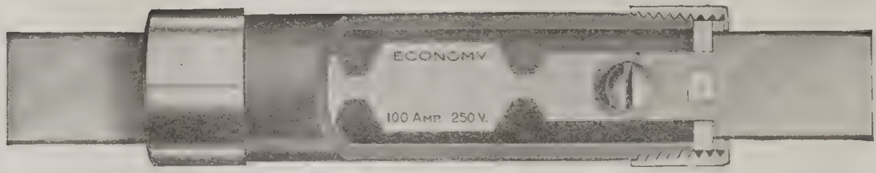

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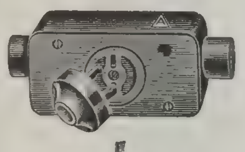

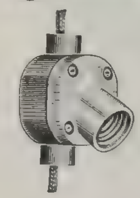

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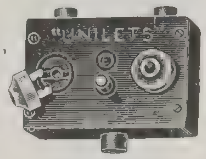

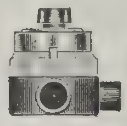

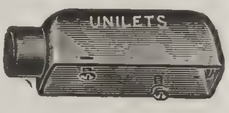

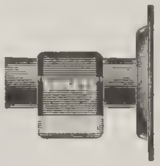

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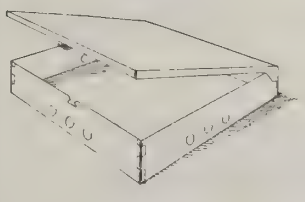

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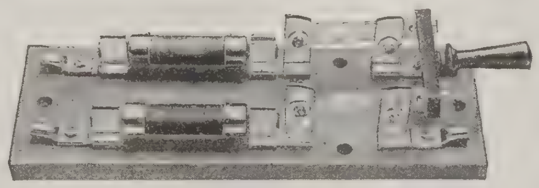

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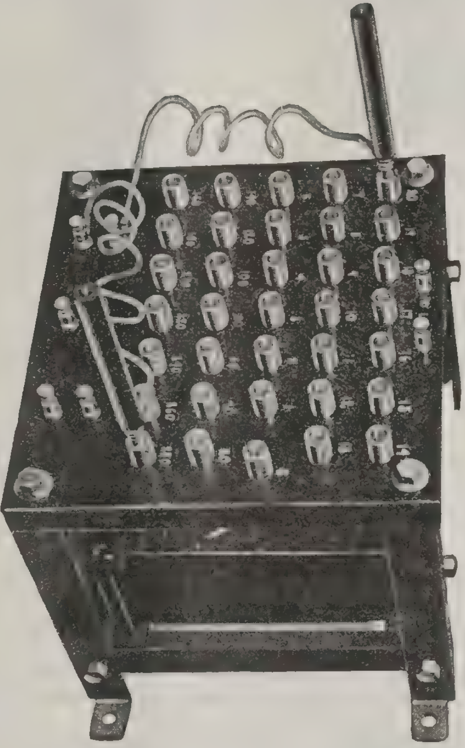

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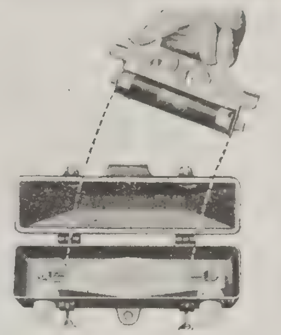

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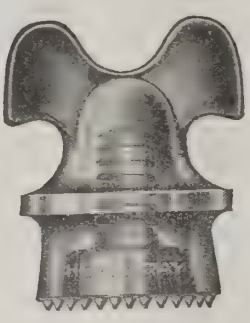

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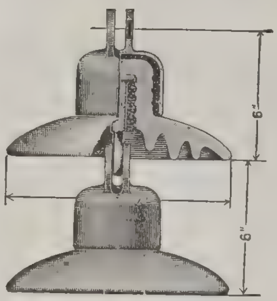
Thomas Insulators



——have high dielectric strength.

——are very strong mechanically.

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The cut shows Insulator No. 1113, a popular design for 110,000 volt lines.

Send for our new catalogue No. 12, giving complete data on insulators to suit your particular requirements.

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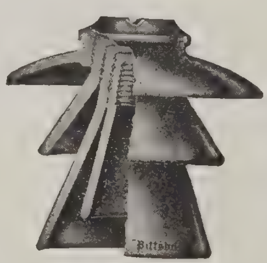

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If it is anything regarding
Power Plant Layout—Sub-Station
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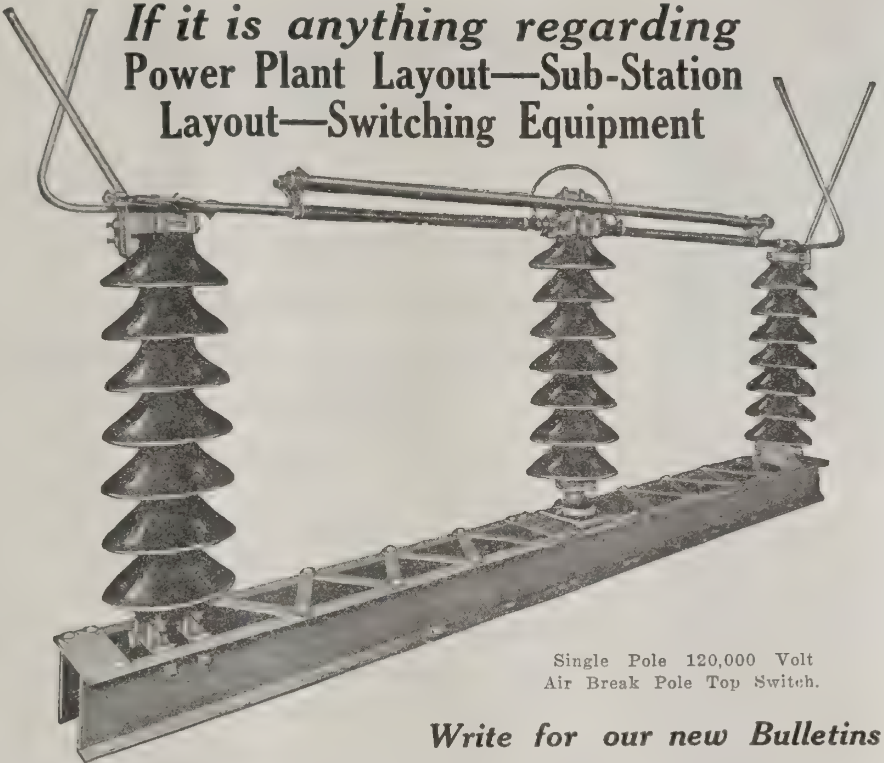

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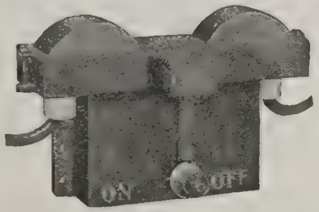
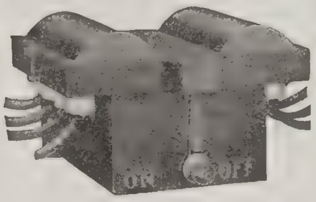


SINGLE POLE



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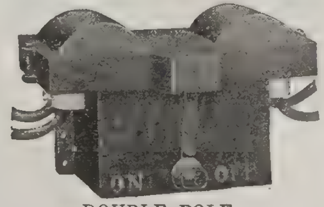
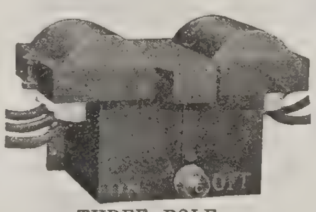


DOUBLE POLE



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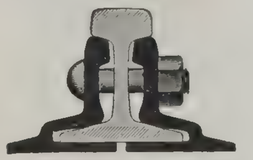

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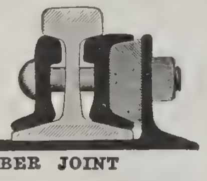

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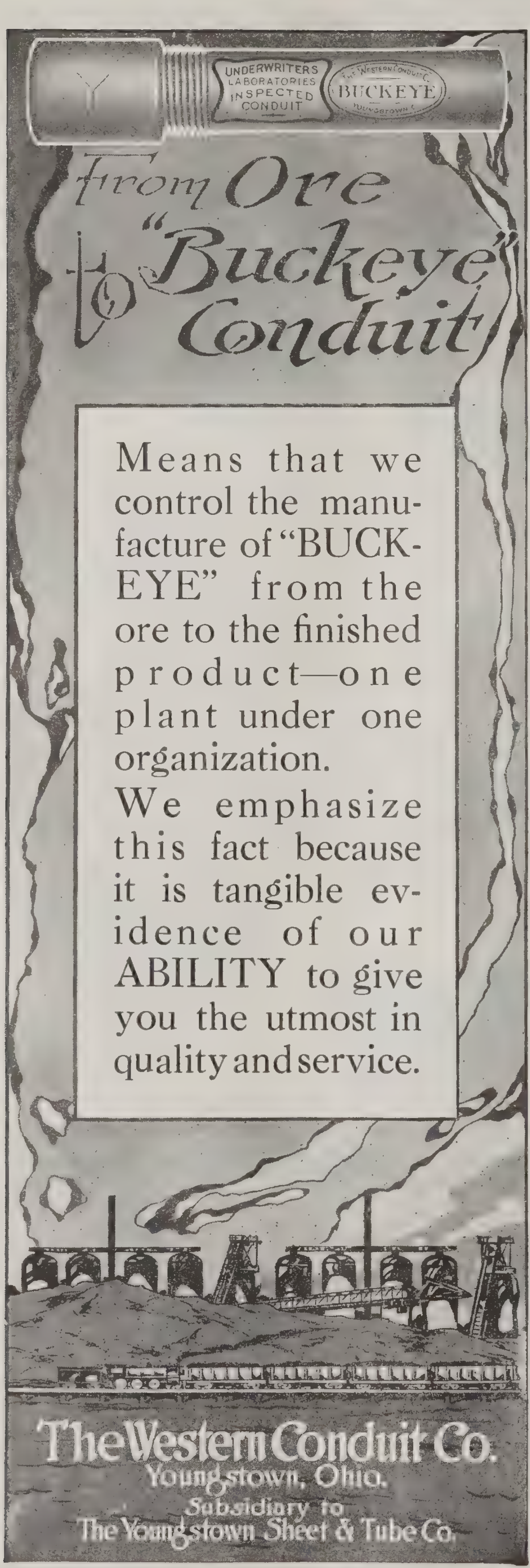
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From Ore to "Buckeye" Conduit

Means that we control the manufacture of "BUCKEYE" from the ore to the finished product—one plant under one organization.

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All sizes from 20 to 75 foot
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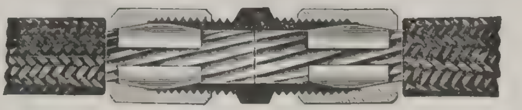
The advertisements in *Electrical Engineering's* FOR SALE ad section, are constantly bringing together those who buy, sell, or exchange machinery. They convert idle commodities into useful cash, and idle cash into useful commodities. The cost is a trifle, the results considerable. If you have something for sale, get your ad in the For Sale columns of *Electrical Engineering.*



Type A—2-way, Showing Detail.

DOSSERT Connectors and Terminals Connect Without Soldering

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The cost of the time required in soldering, in making up connections, make the use of DOSSERT CONNECTORS of interest to any electrical contractor.

While the cost-saving consideration is doubtless known to every contractor, where used in the large sky-scrapers, it is most important to recognize that the saving is so great that they should be installed in buildings of lesser size.

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H. B. LOGAN, President

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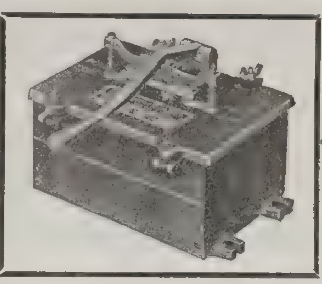

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Starter
No. 6351

3-phase
30 Amp.
250-Volt

Economical, Wear-Resisting and Non-Hazardous in Operation

Wherever installed ''Detroit'' Induction Motor Starters have made good from the start as automatic safety devices for operators and machines, in lowering the fuse cost of operating, and in the ability to stand up under continuous service.

''Detroit'' Starters are absolutely safe to operate—even the most inexperienced workman may use it without fear of accident—it automatically protects the motor from disability through any negligence of the operator.

They have shown that as high as 75% saving may be made in the fuse renewal expense, while the high quality of materials and workmanship used is such that thousands of continuous operations failed to show any wear on the mechanism.

Complete enclosure of all live metal parts with mechanical control on the outside of the box makes real ''Safety First'' arguments in favor of the ''Detroit'' Induction Motor Starters over any other similar device.

Write for our liberal proposition and Bulletin No. 29

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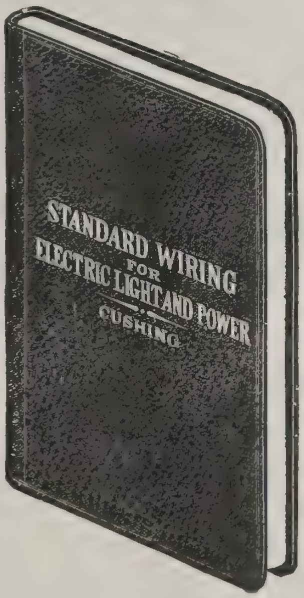

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THE PROTECTED THREAD
ENAMELED
CONDUIT

A Time Saving Test

Score the fibre Thread Protector with your pocket knife, and in four seconds by your watch you have removed it. An actual test, proved with PITTSBURGH STANDARD, by a man who never before had a piece of conduit in his hands. You find the threads clean and true—as free from enamel as the moment it left our threading machine. Coupling threads, too, are free from enamel. PITTSBURGH STANDARD costs no more than ordinary conduit. It saves time and money. On every job it adds to your profits.

Demonstration sample on request.

Test it for yourself.

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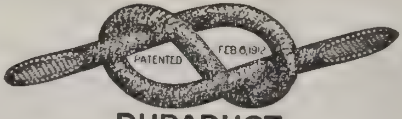

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The leader of the market in quality, method of shipment and service.

Immediate shipments in clean, corrugated fibre cases, and when it arrives it's fit to use. Ask your jobber.

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STANDARD
Cable Terminals

stand for maximum protection to cable insulation, convenience and flexibility in operation and ease of installation.

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"They take up their own wear."

Used with automatic machinery, milking machines, printing press feeders, mailing and wrapping machines, sand blasts, blow pipes, furnaces for melting, annealing, brazing, forging, soldering, creating high heat with oil and gas burning appliances, Vacuum Cleaning. Air storage tanks not required. The air is delivered in large volume at any pressure desired directly from the machine. Simple construction—can't get out of order. Few working parts and these large and strong.

Displaces Noisy and Puffy Blowers

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U. S. Efficient Brushes are self-lubricating, made of the finest grained material, blended, subjected to a special lubricant, molded and tempered. They give maximum brush life with a minimum commutator wear. They produce high commutator polish and are absolutely self-lubricating throughout their life. They are manufactured to meet the most exacting conditions in generator or motor service and are backed by a perfect guarantee. The saving effected in maintenance will pay their first cost. We will gladly furnish you free samples. Write us today.

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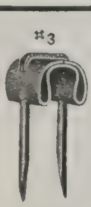

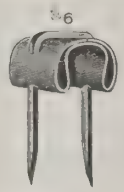

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5 Sizes
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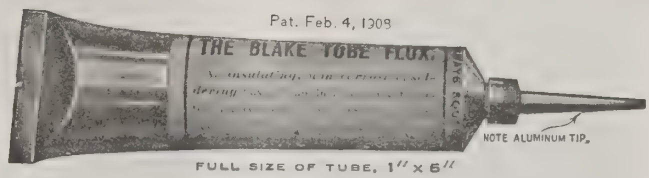

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THAT'S WHAT WE OFFER, FOR THERE'S NO FRICTION OR WEAR WITH THESE FIBRE GRAPHITE BRUSHES. BEING 90 PER CENT. PURE GRAPHITE INSURES LOW RESISTANCE, NO SPARKING UNDER VARYING LOAD, LONGER WEAR AND NO GREASING.

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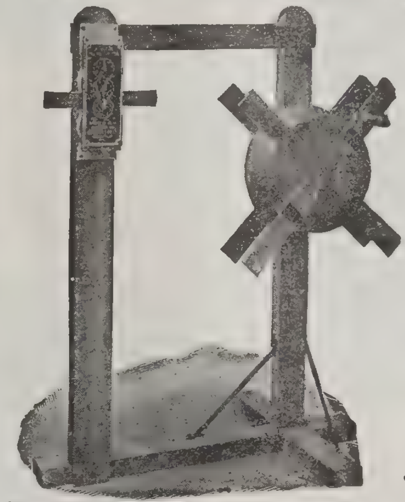

This Wire Reel and Meter

will save time and money for any electric supply dealer or contractor. Meters with base made in two sizes—for wire, and for cable or flexible conduit. Write for full particulars and prices.

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Special Transformers

THE STATES COMPANY, Hartford, Conn.
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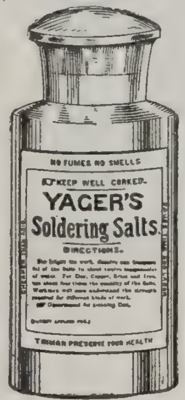

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Yager's Soldering Fluxes

at hand, you can solder any kind of metal. Most welcome in emergencies; You can use it anywhere, any time, under any conditions; the more you use it, the better you like it. Our best customers began to use it 40 years ago.

YAGER'S Fluxes are made in four forms—Salt-Stick-Paste-Fluid. If your dealer can't supply you, send us his name and address with your request for free trial sample.

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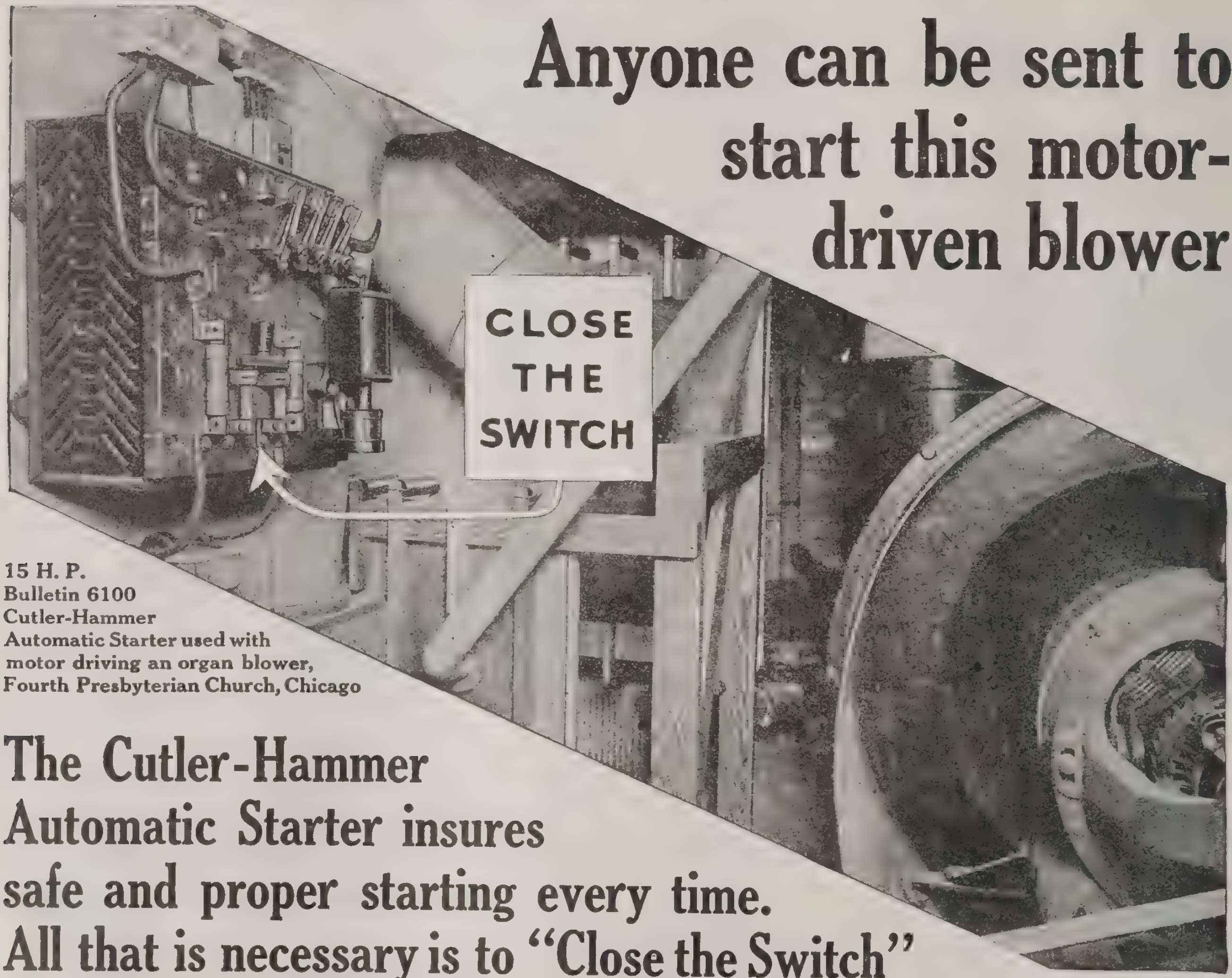
Ask Us To Help You

Our corps of editors are always glad to assist you in solving your problems. If they do not have the necessary information at hand, they can quickly secure it. The next time you have a problem to solve write our Information Department.

Electrical Engineering, Atlanta, Ga.

CUTLER-HAMMER

Anyone can be sent to start this motor-driven blower



**15 H. P.
Bulletin 6100
Cutler-Hammer
Automatic Starter used with
motor driving an organ blower,
Fourth Presbyterian Church, Chicago**

The Cutler-Hammer Automatic Starter insures safe and proper starting every time. All that is necessary is to "Close the Switch"

A motor that has to be started by any one of a number of persons should be provided with the automatic type starter instead of the hand operated type.

Where the operator is unfamiliar with electrical apparatus or apt to be careless in using a hand starter, the automatic starter is preferable. It insures the motor against improper starting. The closing of a switch or the pushing of a button is all that is necessary. The motor is brought to full speed in the same correct manner each time, regardless of who closes the switch.

The ease of starting and stopping encourages shutting down the motor when not in use—power is saved.

For motor drives where dashpot type acceleration is not best adapted, current limiting type automatic starters are furnished.

Ask for Automatic Motor Starter booklet.

THE CUTLER-HAMMER MFG. CO. MILWAUKEE

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PACIFIC COAST AGENTS: H. B. Squires Co., 579 Howard St., SAN FRANCISCO, San Fernando Bldg., LOS ANGELES
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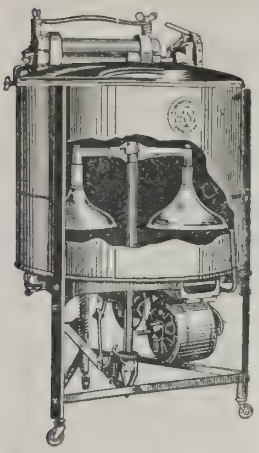


It Almost Sells Itself

Electrical Dealers and Central Stations have hesitated to add the washing machine to their line because of the troubles incident to damaged clothes, breakdowns, personal injury due to exposed mechanical parts, etc.

There's no need to hesitate when the "EASY" Washer is concerned. You can handle THIS machine with pride in presenting it and with absolute confidence that every machine you sell will not only give perfect satisfaction, but will sell more of them for you.

Don't wait for the business to turn up. Go after it. People are waiting for a perfectly satisfactory washing machine—and many dealers and stations are not losing time about converting them into customers. How about you?

The "EASY" Motor Washer means SUCCESS for you right from the start. It's many superior points will practically sell itself.

Write at once for our proposition.

Dodge & Zuill, 5084 E. Water St., Syracuse, N. Y.

More Light—Better Light—Lower Cost

Replace your flickering, expensive, and unsatisfactory arc lamps with our

High Efficiency Nitrogen Filled Lamps

The light from these lamps more nearly resembles daylight than that of any other lamp that has been produced. The ideal light for factory and store illumination. Try them.

Do you want a good, reliable tungsten lamp? One that can be sold entirely on its own merit? Then order a case of

Regent Wire-Drawn Tungsten

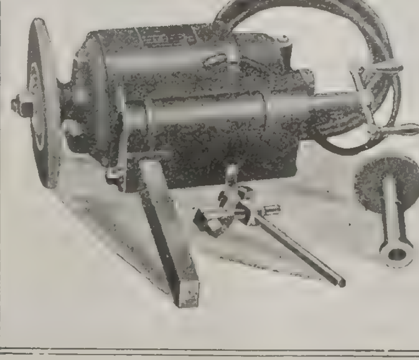
on thirty days' approval. Remember to specify "Regent" when ordering.

Our large and varied stocks ensure prompt and efficient service. We can quote you very Attractive Prices.

Drop us a card stating your requirements and order a trial case; then we can talk quantity prices that will surprise you.

REPRESENTATIVES WANTED IN THE SOUTH.

New York Electric Lamp Company
Sales Department. 38 Park Row, New York City



STOW Tool Post Grinder

Plain or with slide. Most accurate tool of its kind on the market.

Manufactured by
Stow Mfg. Co.
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Oldest Portable Tool Manufacturers in America.

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GENERAL MOTORS COMPANY
TRUCKS

Practical transportation men agree that wherever the electric truck can do the work required it is the most economical and dependable type of power vehicle to use.

These qualities of economy and reliability are emphasized in GMC Electrics because of exclusive features that make for easy care, low maintenance cost and simplest operation.

There are eight load capacities from 1000 lbs. to 6 tons, each in varying chassis lengths—a truck for every business need.

We also make a complete line of gasoline trucks from 1500 lbs. to 5 tons capacity.

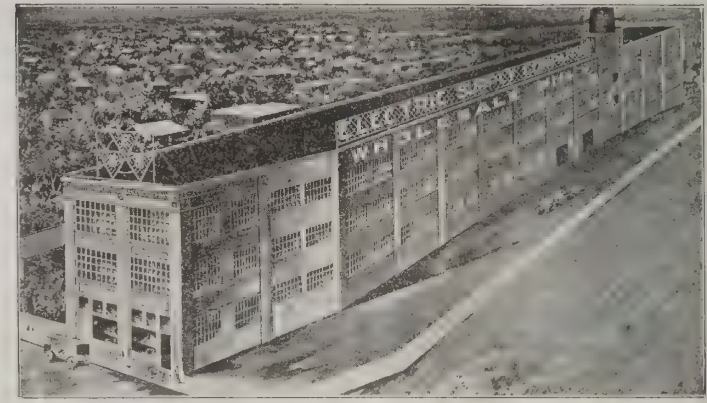
Catalogs and details for the asking.

GENERAL MOTORS TRUCK CO
One of the Units of General Motors Company
PONTIAC, MICHIGAN

Branches: New York, Boston, Chicago, Philadelphia, Kansas City, Detroit, St. Louis.

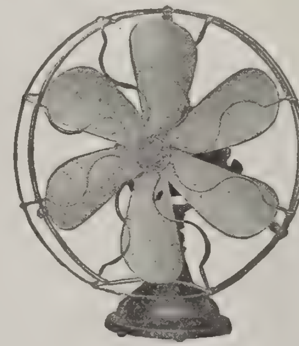
Our Warehouse

The best equipped electrical supply establishment in the South, made possible by our satisfied customers.



Our Superior Lines

Edison Mazda lamps—General Electric fans and products—Fort Wayne Electric Co.—Phillips Insulated Wire Co.—National Carbon Co.—American Steel & Wire Co.—American Telephone Co.—Sprague Electric Co.—Indiana Steel & Wire Co.—Hotpoint Electric Heater Co.



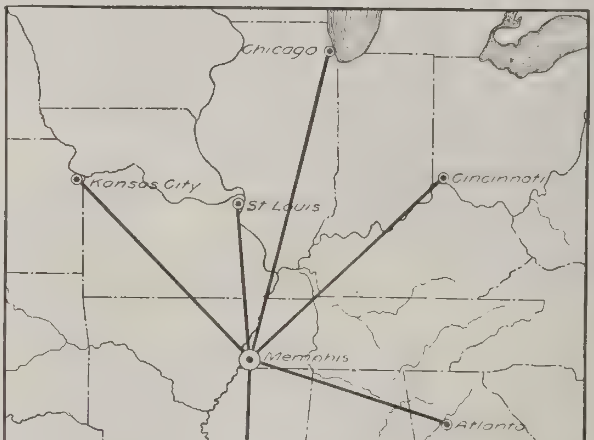
Our Inexhaustible Stocks

Geographically located as we are, we are enabled to draw quickly on the General Electric Company's stocks in six large cities. Our stocks are, therefore, practically inexhaustible, and we assure our customers of the same prompt service on large orders as well as small ones.

We devote our entire energies to the electrical supply jobbing business of the South.

We do not handle retail or contracting business, and we carry no hardware, mill, or automobile supplies.

Write today on your company stationary for our big catalog—or better still, give us a trial order and let us show you what Memphis Service is.



Electric Supply Co.,

Memphis,
Tennessee.

The Quality Lamp

WHEN you take a customer's money in exchange for a lamp you are the one he holds responsible for its quality. The reputation of your house will profit or suffer in degree according to the kind of service that lamp will give. When, therefore, you place your name back of National MAZDA lamps, you are perfectly justified in demanding an assurance of their high quality.

National MAZDA lamp quality is founded on the technical knowledge of experts. National MAZDA lamps are the culmination of years of effort on the part of the Research and Development Laboratories of the General Electric Company at Schenectady and Cleveland—laboratories that have access to every improvement produced in other leading laboratories of the world.

But just as important as this basis of National Quality is the maintenance of that quality by careful methods of manufacture, by a rigid inspection of all raw materials, by a constant testing of product and by a vigilant lookout for improvements that will still further raise the standard of quality.

From factory to socket National MAZDA lamps mean satisfaction.

NATIONAL LAMP WORKS
OF GENERAL ELECTRIC CO.
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Member Society for Electrical Development: "DO IT ELECTRICALLY"

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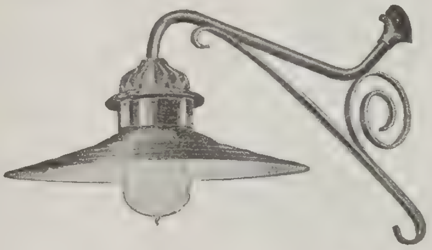
"Will Sell Light in New Places and More Light in Old Places."



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can be used.

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To Each and Every One of
Our Friends

for Christmas
and the New Year

"May the Christmas tide bear you to the highest level of your desires, and the ebbing year leave you stranded upon golden shores of peace, prosperity and happiness."

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"The Auto and Electric Shop"

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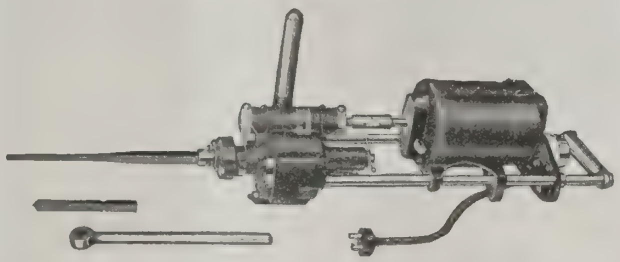

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Design for Drilling Holes in Concrete, Stone, Brick, Tile, Marble and Similar Materials. Universal Motor Operating on Either Direct or Alternating Current. Portable and Efficient. Write for Bulletin 200-E.

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Mfrs. of Everything for Electric Heating and Cooking.
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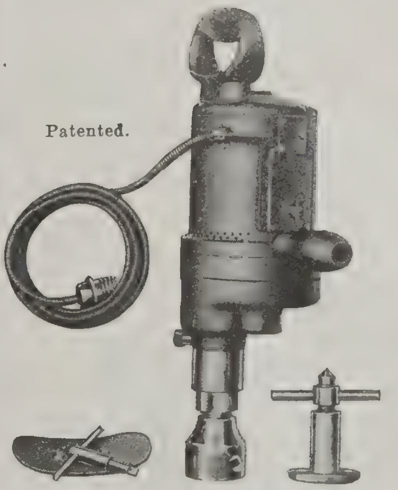

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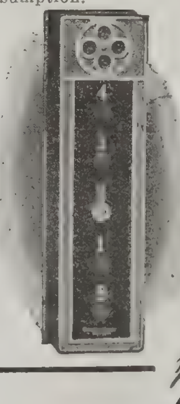

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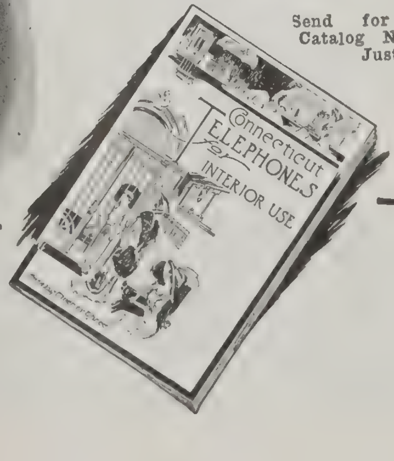

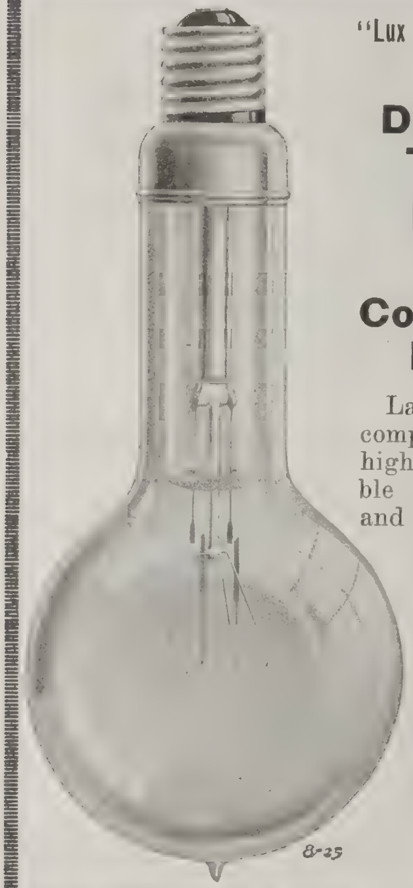

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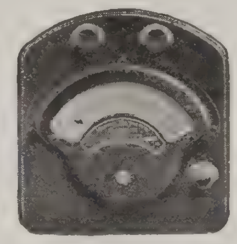

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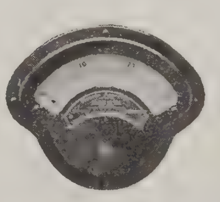

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Volt-Meters, Millivoltmeters Volt-Ammeters. Ammeters, Mil-Ammeters

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Voltmeters, Volt-Ammeters, Ammeters, Mil-Ammeters.

This new line of instruments represents the finest development of small size pivoted moving coil, permanent magnet type of instruments.

They embody characteristics which have made the well-known Weston Standard famous throughout the world.

They are accurate, dead beat and extremely sensitive.

They may be left continuously in circuit at full load and are shielded against external electrical and magnetic influences.

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The STANDARD *for* RUBBER INSULATION

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When you get the habit of using OKONITE Insulated Wires and Cables, you have met success more than half way.

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Made in Bridgeport.

The "Beers" Lantern is in demand because it is the most convenient, practical, durable, economical dry-battery lantern on the market, strongly made of solid brass or pressed steel, equipped with brilliant Mazda bulb.

An ordinary No. 6 dry battery operates it for fifty hours. Users get from six months to one year's service from one battery at a cost of 25c. Instantly appeals to housekeepers, automobilists, farmers, sportsmen, yachtsmen, watchmen, deliverymen and others. A gift gladly welcomed.

JOBBERS AND DEALERS

Your profits are liberal and big sales are quickly made. Write at once for liberal discounts. Jobbers can have large orders furnished under own trade mark or brand. Write today.

THE BEERS SALES CO:, Bridgeport, Conn.

"2-TON CENTRAL STATION UTILITY TRUCK.
1915 G.V. CATALOGUE NOW READY."

GENERAL VEHICLE COMPANY, INC.
LONG ISLAND CITY, NEW YORK
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What to Buy and Why---Told in Catalogues Just Issued

The following catalogs have just been published by the companies named and can be secured without charge by writing to the addresses given. Many of these catalogs contain data you will value.

No.	Name	Company
	Stamped Steel Fixture Studs	National Metal Molding Co., Pittsburgh, Pa.
121	Steel Frame D. C. Motors	Robbins and Myers Co., Springfield, Mo.
	Hoyt Miniature Voltmeter and Ammeter	Hoyt Elect. Inst. Works, Penacock, N. H.
	Semaphore Annunciator	Edwards and Co., 140th and Exterior Sts., N. Y.
38	Sidewalk Signs	Greenwood Advertising Co., Knoxville, Tenn.
	All Metal Seals	Metropolitan Engineering Co., 42nd St. Bldg., N. Y.
	Subway Cutouts, Cable Rackets	Metropolitan Engineering Co., 42nd St. Bldg., N. Y.
	Primary Pole Cutout Switch	Metropolitan Engineering Co., 42nd St. Bldg., N. Y.
	D. C. Cable Testing Ammeter	Metropolitan Engineering Co., 42nd St. Bldg., N. Y.
	Dim-a-Lite, Turn Down Attachment for Lamps	Wirt Co., Germantown, Pa.
	Push Button Specialties	Cutler Hammer Mfg. Co., Milwaukee, Wis.
16	Arrow Wiring Specialties	Arrow Electric Co., Hartford, Conn.
	U. S. Government Report on Cypress	Louisiana Red Cypress Co., New Orleans, La.
	Profitable Electrical Merchandising	Western Electric Co., New York City.
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	Helping the Woodworker	Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
3042	Motors and Machine Tool Service	Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
3078	Central Station Power in Coal Mines	Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
8	Situation Before Cotton Textile Mfgrs	Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
3749	Synchronous Booster Rotary Converter	Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
	Hoover Suction Sweeper	Hoover Suction Sweeper Co., New Berlin, Ohio.
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10	Cast Metal Outdoor Lighting Fixtures	Herwig Art Shade and Lamp Co., 2140 N. Halstead St., Chicago, Ill.
	Tests of Metal	The Consolidated Expanded Metals Co., Pittsburgh, Pa.
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	What Users Say About Cooper Hewitt Light	Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
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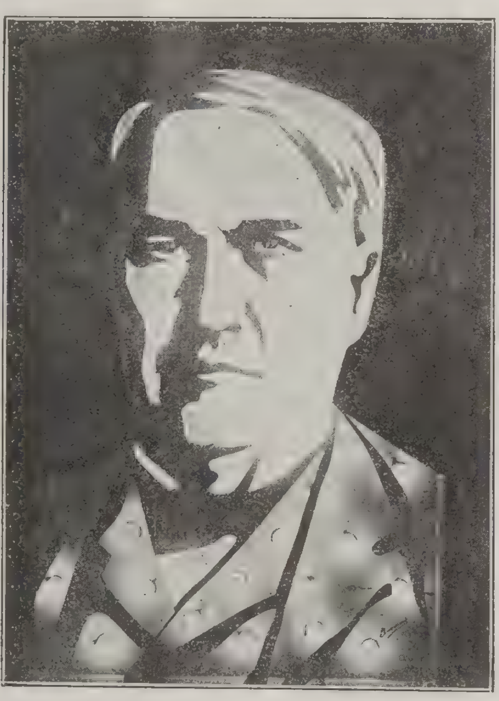

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makes a quicker and more lasting impression than reading matter. Advise your prospective electric sign customers of Greenwood Signs. They stand pre-eminent because of their

Individuality

Have one of our new Shadow Pictures installed and see the interest created. It is a sample of Greenwood Individuality, and Greenwood Individuality reminds you of everything that is snappy, and artistic in electric signs. Get your customer's idea and we'll work out the design.

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KNOXVILLE, TENNESSEE.
Greenwood Advertising Co. (Western) Los Angeles, Cal.

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2. Absolute homogeneity and uniformity.
3. Self lubrication (lubricating agent being pure graphite).
4. Maximum brush life with minimum commutator wear.
5. Perfect brush and commutator surface.
6. Lowest cost per machine hour per brush.
7. Lowest cost per machine hour per commutator.

Thousands of satisfied customers throughout the world have found the above statements to be absolutely correct.

This is your opportunity to reduce your brush and commutator expense. Write for Special Proposition.

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United States Factory: Brooklyn, N. Y., U. S. A.

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Photometrical tests of all forms of commercial illuminants. Illumination tests made anywhere indoors or outdoors.

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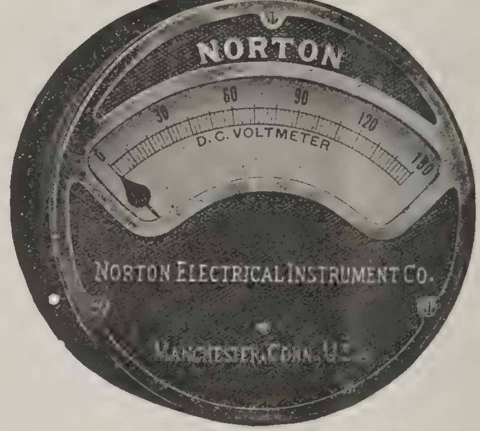

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(D'Arsonval Type)
SWITCHBOARD INSTRUMENTS

NORTON Instruments represent QUALITY, ACCURACY and DURABILITY

Prompt Service and Satisfaction Guaranteed. It will pay you to write for Discounts.

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Marion Insulated Wire & Rubber Co.
Okonite Co., The
Samson Cordage Works.
Simplex Wire & Cable Co.

Cord—Telephone.
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Simplex Wire & Cable Co.

Cord, Trolley.
Samson Cordage Works.

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Southern Exchange Co., The
Turner Elec. Supply Co.
Western Electric Co.

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Brady Elec. & Mfg. Co.
D & W Fuse Co.

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Fort Wayne Electric Works.

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Electric Tachometer Co.
Stow Mfg. Co.

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Schwartz & Land.

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Westinghouse Mach. Co.

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R. Thomas & Sons Co.

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Hazard Mfg Co.
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Western Electric Co.

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Esterline Co.
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Western Electric Co.

Porcelain.
Cook Pottery Co.
National Elec. Supply Co.
Pittsburg High Voltage Insulator Co.
R. Thomas & Sons Co.

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Okonite Co., The

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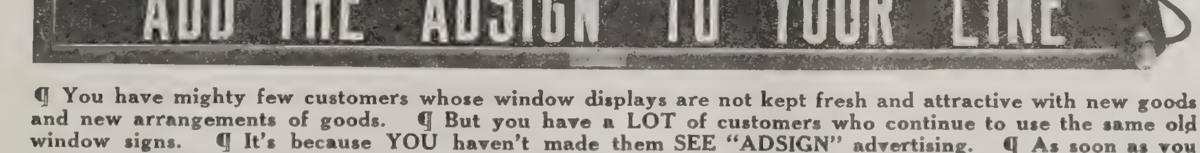
Pittsburg Reflector & Illuminating Co.



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Turner Elec. Supply Co.
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Weston Elec. Instrument Co.
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Allis-Chalmers Mfg. Co.
Central Tel. & Elec. Co.
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Adam Elec. Co., Frank
Central Tel. & Elec. Co.
Cutler-Hammer Mfg. Co.
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Western Electric Co.

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Leffel & Co., James

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Driver-Harris Wire Co.

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American Steel & Wire Co.
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Phillips Insulated Wire Co.
Roebling's Sons Co., John A.
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Standard Underground Cable Co.
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Replies may be sent care of ELECTRICAL ENGINEERING, Atlanta, Ga.

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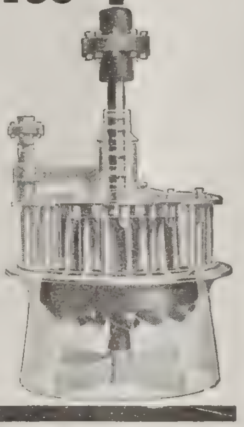

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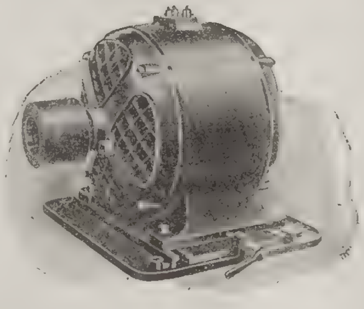

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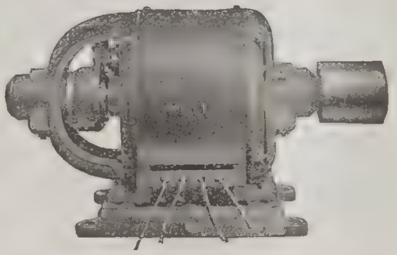

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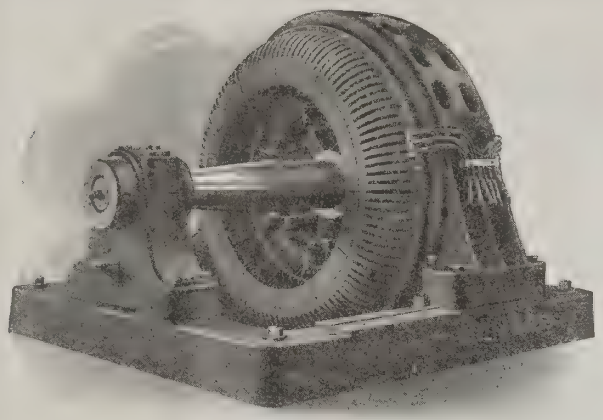

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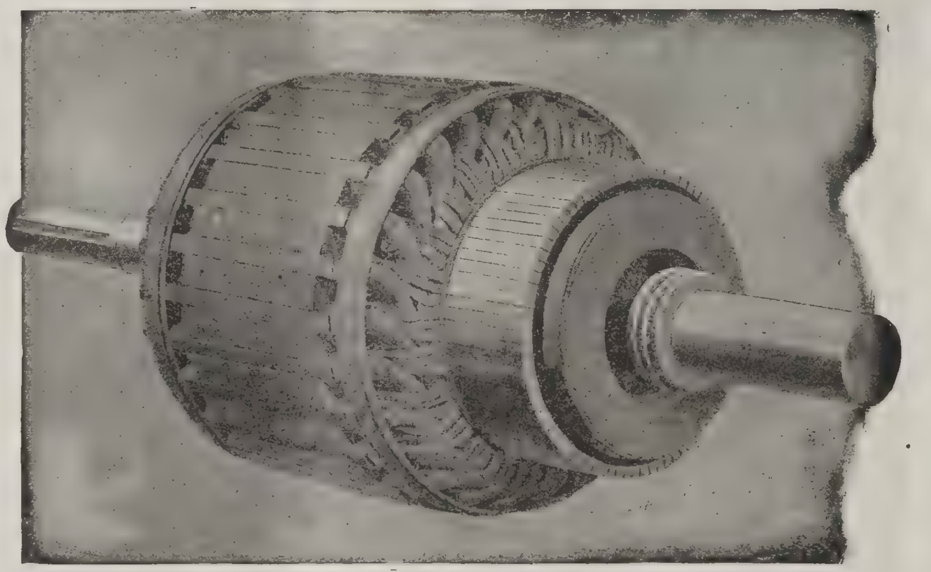

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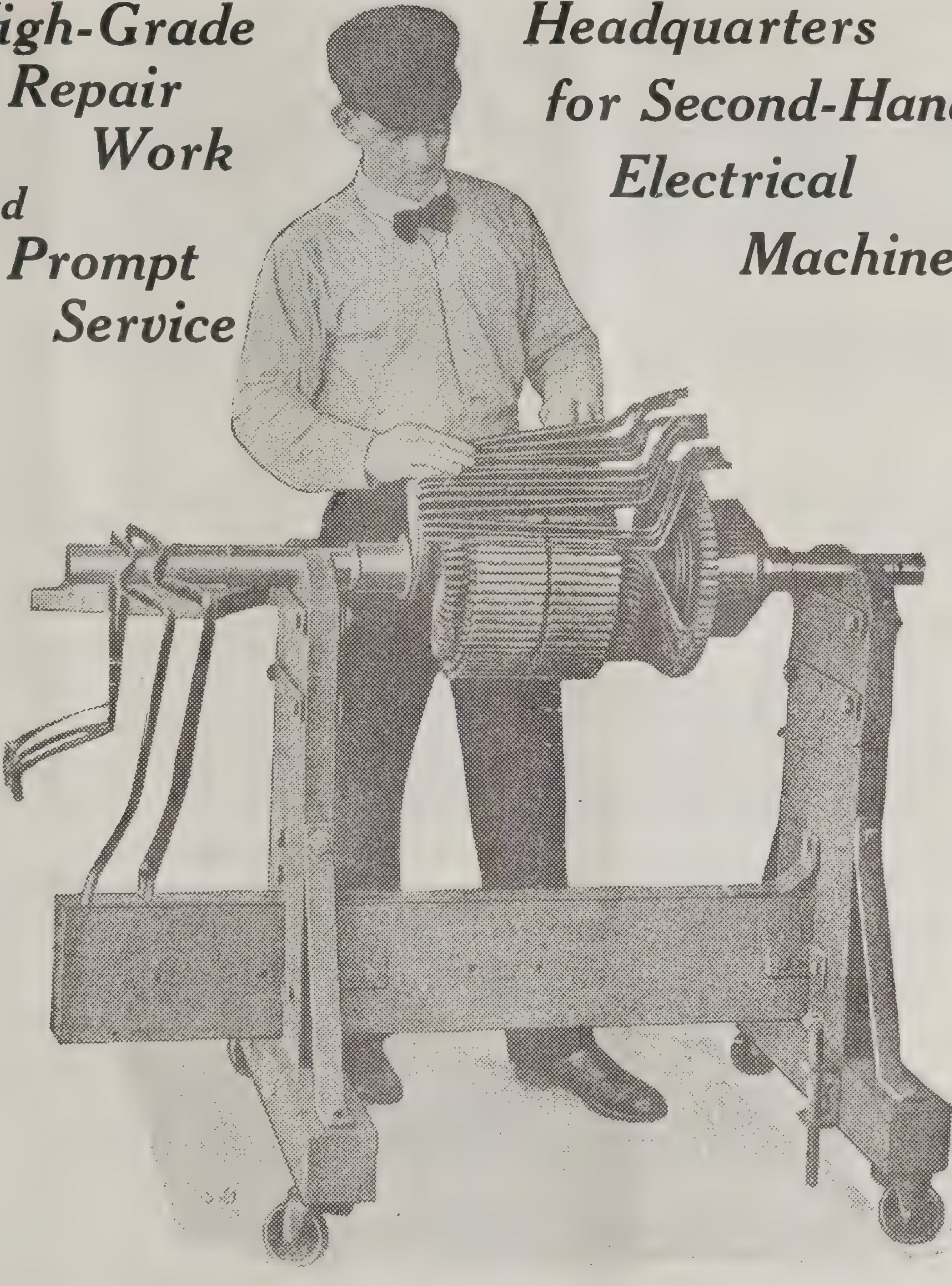

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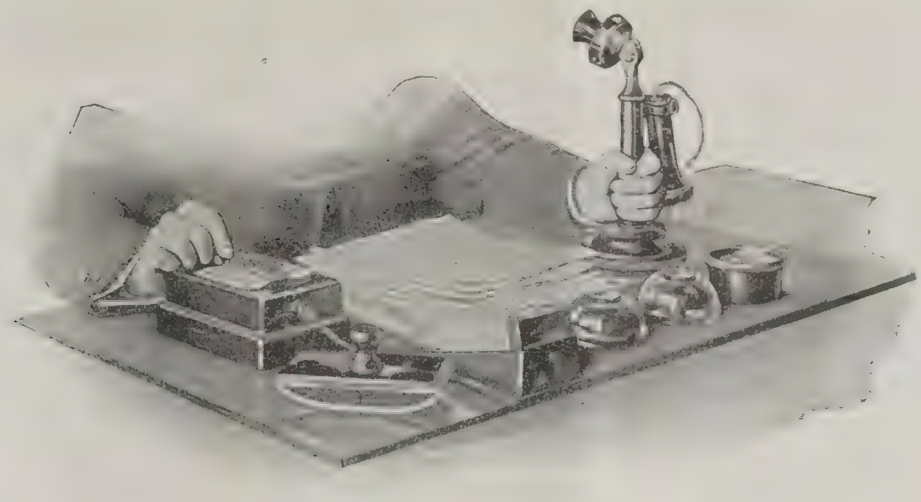

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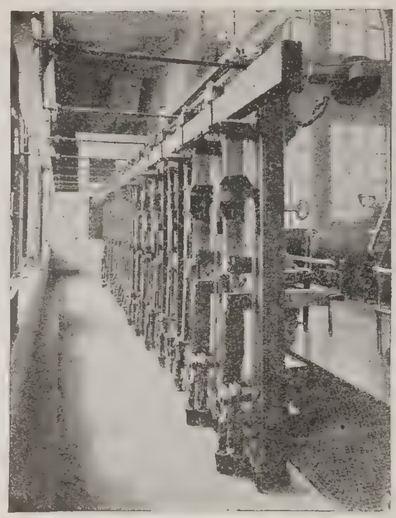

Fig. 1

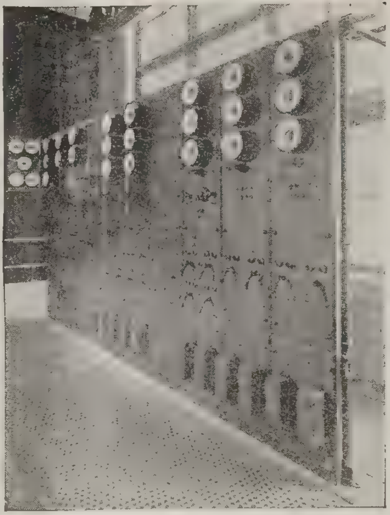

Fig. 2

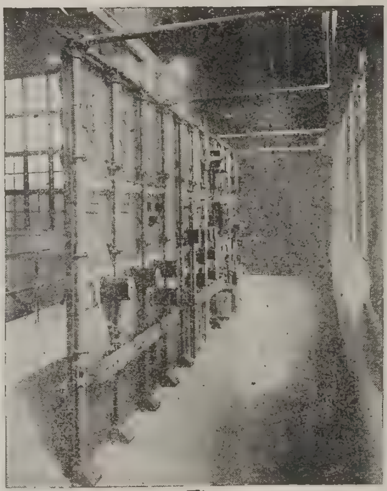

Fig. 3

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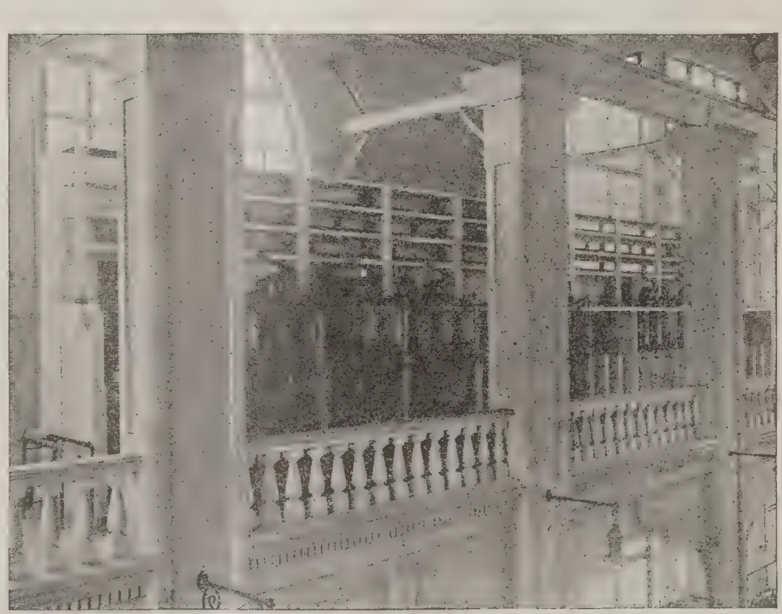
Figure 4 shows Type E cell mounting breakers with operating mechanism mounted above the breaker.



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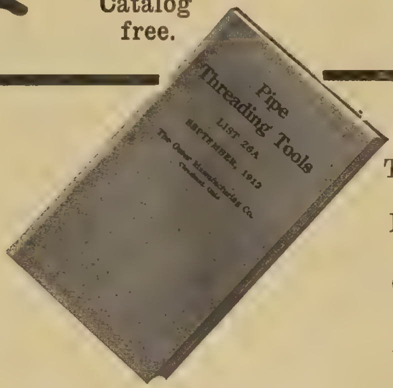

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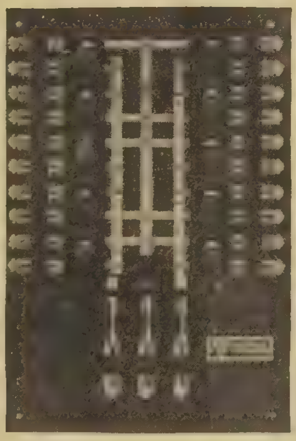

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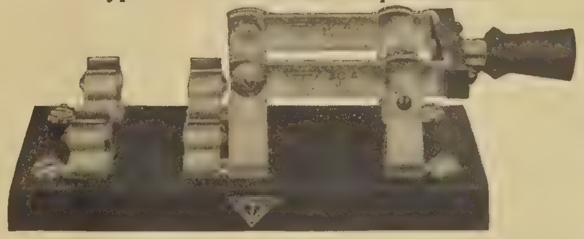

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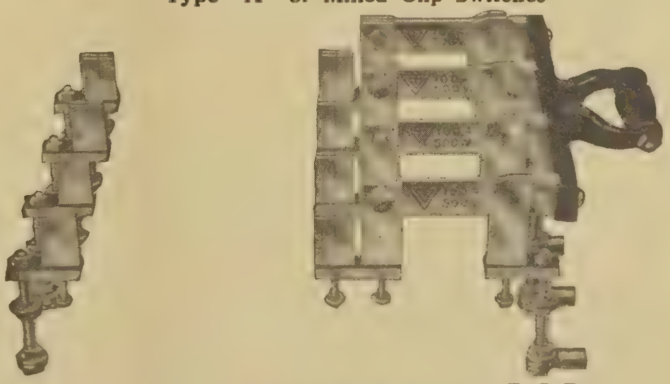

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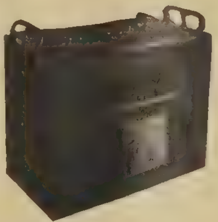

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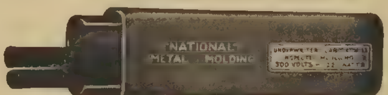

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